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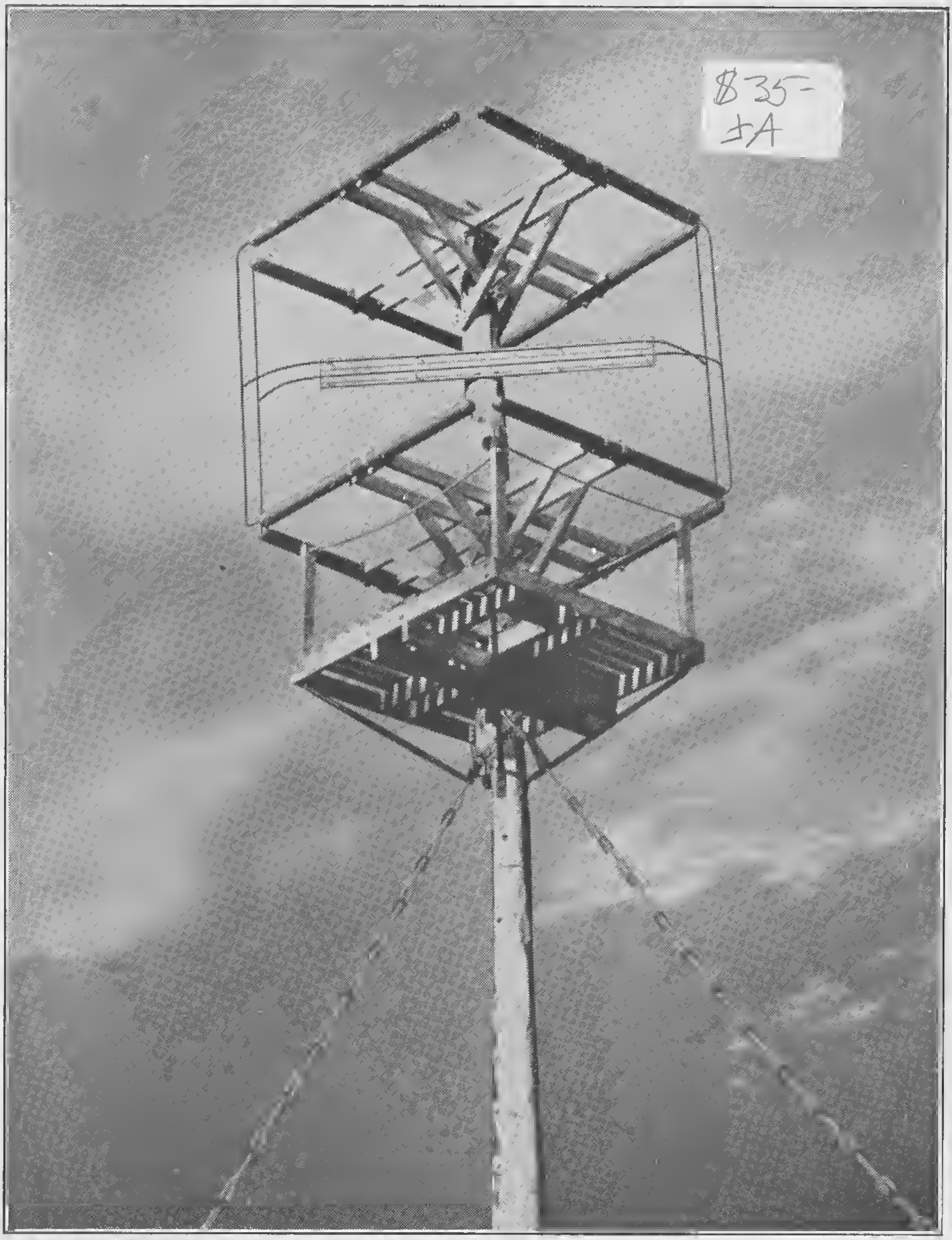
QUESTION MARK



TELEVISION ANTENNA

(See Inside Cover)

COVER . . .

Photo courtesy of

General Electric Co.
Schenectady, N.Y.

●

This picture shows the Cubical Television Antenna designed by G-E engineers for Television Broadcasting Station WRGB. Two of these have been erected, one to send voice and other the picture. The Station is in the Helderberg Mountains in New York State.

Photo Courtesy DR. G. O. LANGSTROTH

SCIENCE BUILDING

LIST of ARTICLES

THE QUESTION MARK

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VOL. 12 No. 1

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Einstein Is Worried About You

by DYSON CARTER

PROMINENT Canadian scientists seem to be taking small interest in the critical problems our country will face after victory. The situation is not good for Canada, decidedly bad for our young scientists and engineers.

In the last few years I have met a good many British, American and Canadian scientists. The latter are distinguished by their reserved attitudes towards social, economic and political issues. Often they are afraid. Many can still be frightened by the Red Bogey, so that you find them figuratively poking under the bed for a legendary bolshevik hefting a bomb. In University, government bureau, and industry, the mere suggestion that scientists actively take part in the vigorous political life of our young country is enough to cause an outbreak of psychical hives.

Don't think I'm being smart. This is a candid article. I'd hate to see the science graduates of '46 and thereafter go through what my classmates and I put up with in the 'thirties. Right now there are grads of '43 who are being paid, for important war work, salaries which no self-respecting trade unionist would take. Canadian scientists and engineers are still taught the dogma that technicians should beat a track between the laboratory and their home fireside, with never a critical look at the world in between.

Suppose the labs close down and there's no money for coal on the fireplace? Brother, it happened once!

To a science correspondent the contrast between Ottawa and Toronto on the one hand, and Washington and New York on the other, is painful. In the recent presidential elections the mighty "Arts and Science for Roosevelt" committee was headed by Dr. Harlow Shapley, one of the world's greatest astronomers, director of Harvard College Observatory. He was no gingerbread chairman, either. With Orson Welles and even with Frankie Sinatra he stumped the country for FDR's party. Would ultra-conservative Harvard dare to fire Shapley? The question is silly.

Consider Dr. W. C. Lowdermilk, a famous geo-physicist, authority on continental soil conservation and flood control. He has said: "After victory, rather than demobilize the war sciences of the nation, we should keep them fully marshalled, directed towards the problems of peace. We need not less, but more science. Science has too often in the past been a hireling of exploitation and greed. This world wide war may well end the exploitation of humanity." Read that again, knowing that Lowdermilk is a federal employee of the United States.

So far advanced are American scientists that Prof. Leslie A. White, on the faculty at Michigan University, writes in the Anthropological Journal: "At the present time science has outgrown our social system. The great forces of this age are straining within the confines of a system fashioned back in stage coach days. This war is significant because it is the means by which an old order is to be scrapped and a new one brought into being."

Take another Harvard man, Prof. Kirtley F. Mather, who got a very attentive audience

at the Cranbrook Institute of Science when he said: "After this war, the old order will inevitably be replaced by a new order, a new system that is even now being forged on the ringing anvil of history. We know there is enough and plenty to spare of all the necessary raw materials to provide an efficient, comfortable existence for every human being who is likely to be born anywhere on the earth during the next two thousand years at least!"

Before I'm accused of calling for barricades on the campus, let us make some intelligent observations. First, not one of these quoted men are members of the Communist or Socialist political organizations. Second, they realize that the technologist, who made possible our victory in this war, must demand a leading role in planning the years ahead. Third, they understand that the people of the Democracies will not tolerate any return to the mass poverty, sickness, exploitation and police terror of pre-war years. Fourth, they appreciate that behind the ballyhoo of four-color advertisements, research has been criminally sabotaged in our countries for some two generations. Fifth, they see clearly that Science, spelled with a capital, is destined to become the greatest of all forces carrying Mankind towards its splendid goals.

Therefore they draw the logical conclusion: it is urgently necessary for all men and women trained in research and its applications to take a dynamic part in political action. This means to inform themselves and the public on the relation between science and social change. To demand the fullest social application of beneficial discoveries. To organize all technologists for economic self-protection and joint action with organized labor, artists, musicians, actors and writers.

In brief: Science is shaping the future, but scientists are powerless unless they work with and for the people.

The social awakening of scientists has been accelerated by the astounding success of the Red Army, and the high level of Soviet technical and industrial production behind it.

Our medical officers find that Red Army scientists did most of the research on blood transfusion. Our physcists have seen the Soviet scientist Kapitza, who chose to leave England and return to Moscow years ago, showered with international honors for his revolutionary advances in thermodynamic theory and low temperatures. Chemists understand what Russians have done for rocket weapons and super-steels. Biologists are reading up on Lysenko, Efrimov, Bogomolets and the immensely important work of Negovsky on reviving the dead.

My single claim to modest fame is that I predicted Soviet success long before the war, and in 1941 wrote a book outlining Russian technological achievements. That book ("Russia's Secret Weapon") has appeared in seven languages. I mention it for good reason. It brought hundreds of letters from all over the world. Nearly all the comments from British and American scientific men were appreciative. The few Canadian technical experts who commented on the book wrote stinging accusations, claiming I was an imposter, a dreamer of tales. I had to resign from the contributing staff of a periodical because Canadian research men branded my writing sheer falsehood. One went so far as to say that Kapitza didn't exist and his turbine was a Rube Goldberg invention of mine. A few months after I got this *billet doux,* Kapitza was awarded the coveted Faraday Medal, and made headlines in the world science press.

Do I exaggerate? In November 1944 I listened to a convention speech by one of Canada's leading physicists, in which he quite excitedly "announced" the Russian discovery of the underground gasification of coal—a development I have talked about to Canadian workers for three years, and which was discussed in the House of Commons. And again: speaking to a gathering of leading electrical engineers I found that hardly a dozen had heard of Babat's work on practical wireless transmission of power for buses and trains. Even worse: a Canadian vice-president of one of the great research organizations of the world asked me to name a single important Soviet chemical achievement; when I suggested industrial syntheses based upon liquid-phase reactions in liquefied gases, he became so interested in this "unknown" development that he forgot to keep sneering.

Dr. Boris Keller, head of the Soviet Academy of Sciences, sent me a communication in which he said: "It can be confidently asserted that our whole state system represents the stupendous realization and confirmation of science, for the first time in the world. The Soviet Union does not simply use science, it creates it, develops it on an unprecedented scale. Science has become the very flesh and blood of Soviet life."

Professor Blimp will label this pro-Soviet propaganda. Come, now. I simply wanted to

ask, as many British and American scientists are asking: "Why can't science become the flesh and blood of life in our Democracies?"

Maybe that's just an idly rhetorical question. So let me quote from the late Soviet novelist Gorky.

"Life will be action, creativeness, the full realization of science. The aim of our science is the development of the priceless individual abilities of man. Its aim is Man's victory over the forces of nature, for the sake of long life, health, for the supreme joy of living in a world which science can and will mould into a beautiful dwelling place for all Mankind, the whole human race united into a single mighty and joyous family. Here in the Soviet Union we are all becoming scientists, new scientists, technicians of culture, engineers of the human soul, creators of peace and freedom, discoverers of Mankind's noble future."

Why should the U.S.S.R. have a monopoly on heroic idealism? But the Soviet people, not us, have carved in stone Pasteur's greatest words: "The laboratories of Science are the temples of the future!"

Our science is notoriously materialistic. Prof. Robert S. Lynd of Columbia says: "Men have laid violent hands on science." I am sure you do not even faintly grasp the extent to which the decency, the morality of research, is violated in our countries. We have all heard vague stories about the suppression of discoveries, the shelving of patents. But do you realize that the historic Vitamin D discovery of Steenbock at Wisconsin, for example, has been so inhumanly exploited that it has been the cause of crippling numberless children? Here is an example of incredibly savage perversion of science from life-saving to profit-making. Right now the public pays 11 dollars for 15 cents worth of Vitamin D.[1]

Two years ago *The Question Mark* carried an article of mine on penicillin. This bacteriostatic is revolutionizing chemotherapy, if not the whole of medicine. Discovered by Fleming in 1929, its uses clearly set forth then, penicillin was given to the world only after the war halted efforts to suppress it. And a delightfully ironic fact is that today, with fantastic profits being made from penicillin manufacture, Fleming still hasn't received a plugged shilling for his momentous research.

You might remember this true little anecdote when you are asked to believe that only so long as research is left absolutely free from government supervision, and so long as science workers stay out of unions, will there be worth while rewards for the scientists who do all the brain work. Ask Dr. Fleming. Certainly he got a reward. They made him a "Sir", although naturally he had to pay the Royal fee for the Knighthood. Gad, sir, one cannot brush hallowed customs aside for this beggar's smelly penicillin, what!

I agree with Dr. Gardner Murphy, psychiatrist of the College of the City of New York, when he told the American Orthopsychiatric Association: "Individualism is not enough to see us through the present conflict and help to build a postwar world fit to live in . . . we need peace in which not only safety but abundance of life will be made real."

Maybe you'll wince at these remarks by Prof. William Seifriz of the University of Pennsylvania: "The scholar's plea that he has led too isolated a life to understand the world at large is but a blind for his unwillingness to understand, his unwillingness even to attempt to understand. As for the inability of the masses to comprehend his work, that is more nonsense. The scholar likes to imagine that he stands head and shoulders above the masses. But it was a repair shop mechanic who built and flew the first airplane. The mathematics or aerodynamics was undoubtedly difficult for him, but he grasped enough of it to put it to work when some very eminent scientists had said it would not work."

One more fact. The Boston-Cambridge Branch of the American Association of Scientific Workers has lately revealed that the earnings of scientists and technologists have *dropped* during the war. This is a sinister statistical formula chalked up on your personal blackboard.

Einstein is worried about it. This year he took time out from his new six-dimensional gravitation theory to address the National Wartime Conference in New York. Said he:

"Brain workers must unite for common action, to protect their own economic interests and to take thought and action towards the proper organization of the peace. Intellectuals might well take lessons from the working class. Workingmen have done much toward bettering their position in the com-

1. The United States Department of Justice in current suits against the Vitamin D Cartel reveals these facts.

munity, whereas scientists and professional men remain less well protected against arbitrariness and exploitation than the members of any other calling."

When you graduate you'll be asked to join one or more "professional associations". You may be warned against joining the Canadian Association of Scientific Workers. This latter is a new organization, worth investigating. The former have been accused of being directed by big-time employers of scientific labor, of giving "professional status" while doing little to raise the young technologist's wages.

Technology will continue to be a wretchedly paying field until you and those who preceded you through college get powerfully organized, strong enough to strike, and preferably affiliate your organizations with distinguished and intrepid trade union leadership such as that of the C.I.O. Frankly, I do not think that many undergraduates can swallow this. University halls give most of us chronic superiority complexes. All I can say is that having a degree and not having to punch a clock will never impress your landlord and grocer. In the end, if you spurn organizing for self-protection, you'll lose even your dignity.

May I . . . well, a small assortment of my own opinions?

Step down off the scholar's pedestal. Prepare yourself to be pushed around when you leave your classrooms. The Democracies have armies of scientists now, just as they have Air Forces full of pilots. Gone is the glamour from Captain of the Clouds, and from Men in White. We are all going to be just workers. So do some thinking about how you want your scientific work used. Don't be afraid of being called a Socialist or a Communist. When people close the door and ask me furtively if I belong to the C.C.F. or the Labor-Progressives, I ask them "Why?" Give such people a cubic centimeter of encouragement and they'll be whispering "You're not a Catholic, are you?" or "Do you think she's a Jew?"

Then, I'd keep my ideals about science high, if I were you. It will cost you money. But just recall all the strenuously successful Free Enterprisers like Whitney, one-time president of the New York Stock Exchange, Park Avenue churchgoer and all that, who got his varnish rubbed off in Sing Sing.

Anyway, you cannot make a fortune out of research. Not unless you use your talent to cripple babies, or to keep eye-glasses away from 35 million people who are losing their sight (a research fact), or discover how to mix arsenic scientifically with plastic false teeth so that every dentist will be terrorized into paying your company a 5000 per cent protection fee on dentures (also a science true-story).

Pasteur did not rise to a Director's seat on the Bank of France. Darwin got no block of shares in Vickers-Armstrong. And look at Fleming.

Well, wouldn't you give your lifetime if people would point at you: "Look, the guy with the old homberg, he discovered penicillin!"

Several business men have paid a lot of income tax with my research. But now, for the handshake of a steelworker off the night shift, who has been able to grasp what caudal anesthesia will mean to his wife in her next childbirth, I would not take any royalty you could name. For the privilege of discussing the theory of gas turbines all night with a Negro porter—a Ph.D., who can make a living only by making beds—I will let someone else shop around for a Cord sport phaeton.

All I ask is to stand on the sidewalk and watch the people go by, when we've won the People's World. Then researchers who develop wondrous new anesthetics, will know that every worker's wife can have them. Then all the kids will get Vitamin D. Then Dr. Comrade Negro will have his lab across the hall from yours.

If we get together, find out who is against us, organize to take care of those people, and passionately strive to liberate science from the grip of the violent hands laid upon it, it won't be so long before we'll have a world fit for ordinary men and women and children to live in.

PRINCIPLES of TELEVISION

by HAROLD F. BATHO, Ph. D.
Assistant Professor of Physics
University of Manitoba

ELECTRICAL transmission of pictures may be divided into two classes, namely, facsimile and television. Facsimile is defined as the transmission by electrical means, wired or wireless, of a stationary picture. Facsimile is commonly used by newspapers and news services but will not be discussed in this article. In contrast to facsimile, television is the electrical transmission, by wire or wireless, of a transient picture or image.

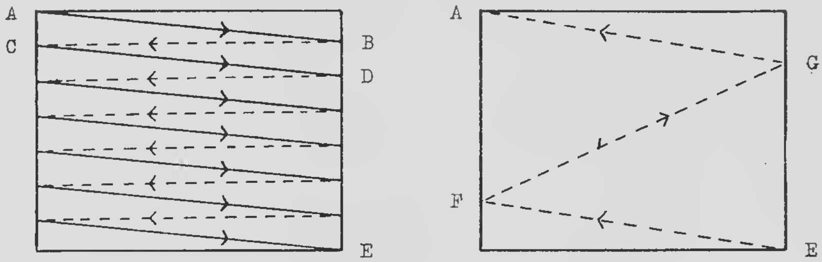
In discussing television it is convenient to think of the complete image which is being transmitted as being divided into a large number of "elements". In theory, two methods of transmission might be suggested. If all elements of the picture are transmitted simultaneously the method is spoken of as *parallel* or *simultaneous transmission.* If the elements of the picture are transmitted one at a time in very rapid succession the method is spoken of as *successive transmission.* All practical television systems so far suggested employ successive transmission. The success of this method depends on persistence of vision in the eye. It is well known that the sensation due to stimulation of any nerve ending in the retina persists for an interval of the order of a thirtieth of a second. Hence, if the entire picture is transmitted within this interval the *observer will receive a simultaneous sensation from all elements of the picture even though the elements are transmitted successively.*

The fundamental processes of television may be conveniently explained by comparison and contrast with the fundamental processes of electrical transmission of sound. In the case of wired transmission of sound, i.e., wired telephony, sound waves striking a microphone create electrical waves of the same frequency and proportional in amplitude to the sound waves. These electrical waves are transmitted by wire or wireless to the receiver in which a headphone or loud speaker recreates sound waves which in the ideal case correspond exactly to the sound waves entering the microphone of the transmitter. In practice it is found that for intelligible transmission of voice the system must be capable of transmitting all frequencies in the range from 100 cycles per second to 3000 cycles per second and for quality transmission of music the system must transmit all frequencies in the range from, say, 50 cycles per second to 8000 cycles per second with fidelity.

In the case of television the picture to be transmitted is "scanned" (by electronic means to be discussed below), i.e., the picture is "viewed" by the transmitter one element after another in very rapid succession. The result of this scanning process is to create in the transmitter an electric current directly proportional in magnitude to the brightness of the particular element of the picture which is being transmitted at that instant. This varying electric current after suitable amplification is transmitted by wire or wireless to the receiver in which a "picture tube" recreates the picture element by element in exact synchronism with the scanning of the original picture at the transmitter. For ideal transmission, the element of the picture being reproduced by the picture tube at any instant must correspond exactly in position and brightness to the element being scanned by the transmitter at that instant. It will be shown later

that for satisfactory reproduction of pictures the system must be capable of transmitting with fidelity all frequencies in the range from thirty cycles per second to four million cycles per second. This range is called the *video frequency range* and is to be contrasted with the very much smaller audio frequency range required for satisfactory transmission of sound.

Since scanning is a fundamental part of all practical television systems it is desirable to discuss the geometry of scanning before dealing with the mechanics or electronics of the process. In the method of successive transmission one small but finite element of the picture is scanned and transmitted at a time. The geometry of scanning is concerned with the order or succession in which the total number of elements making up the complete picture are scanned, i.e., with the pattern followed by the "scanning spot". In commercial practice the picture is scanned linearly from left to right and from top to bottom, i.e., the scanning spot starts at the upper left-hand corner of the picture and finishes at the lower right-hand corner at which point the scanning spot rapidly returns to the upper left-hand corner and repeats. This is illustrated in Fig. 1, the path of the scanning spot from the upper left corner A to the lower right corner E being indicated by the arrows in diagram (a). In this connection it will be noted that the horizontal return is much more rapid (about six times) than the horizontal sweep from left to right and that during this return the transmitter is inoperative. To avoid confusion the vertical return path has been shown in a separate diagram (b). The vertical return is about twelve times as rapid as the vertical downward motion, the horizontal motion continues unchanged during the vertical return and the transmitter is inoperative during the whole time of return. By considering the active lines only it will be seen that the whole picture has been scanned once and only once during the cycle, provided the diameter of the scanning spot equals the distance between the active lines.[1] In order to reproduce fine detail it is evident that the scanning spot must be small and, hence, the number of scanning lines large. Further, to avoid flicker of the reproduced picture the repetition rate must be high. In standard practice the picture is divided into about 485 active lines and the whole picture is scanned thirty times per second.



(a) Downward motion (b) Vertical return

⟶ -- Transmitter operative, i.e., picture detail being transmitted.

⇠ - - - -- Transmitter inoperative, i.e., no picture detail being transmitted.

Fig. 1—Scanning pattern.

In order to obtain good reproduction of a picture it is necessary that the system be capable of transmitting faithfully fine detail in which the brightness of the picture varies rapidly from element to element and, also, that it be capable of transmitting broad flat backgrounds in which the picture brightness

1. In modern practice, two-to-one interlaced scanning is usually employed in which alternate lines are scanned in one excursion over the picture and the remaining lines are scanned in the next excursion. The two excursions are completed, i.e., the complete picture is scanned, in one-thirtieth of a second. This interlaced scanning reduces the tendency of the picture to flicker but is essentially the same as the simpler scanning pattern described.

varies slowly from element to element. These two requirements determine the higher and lower frequency limits, respectively, of the range of video frequencies necessary for satisfactory transmission. Considering the upper frequency limit first, let us assume the extreme case of a fine black-and-white checkerboard picture. In practice, it is found that for satisfactory reproduction of fine detail the system must be capable of transmitting a checkerboard pattern in which there are five or six hundred squares across one scanning line. Since the electric current produced in the transmitter by the scanning process is proportional to the brightness of the picture element scanned, one pair of squares (i.e., one white and one black) gives rise to one crest and one trough in the current wave or, in other words, one pair of squares creates one cycle of current. If there are three hundred pairs of squares across the picture there will be three hundred cycles of current per scanning line. Since the picture is divided into roughly 500 lines, 150000 cycles of current are created in scanning the picture once and since it is scanned thirty times per second the frequency of the resulting current will be 4500000 cycles per second. *Any system which is incapable of transmitting a current of this frequency with fidelity will fail to reproduce such fine picture detail as that assumed above.* On the other hand, if the picture to be transmitted is very flat and lacking in detail, the current created by the scanning process will vary slowly from crest to trough. In an e: treme case there might be not more than one cycle of current produced in scanning the picture once or, since the picture is scanned thirty times per second, the current will have a frequency of only thirty cycles per second. *In order to reproduce broad flat backgrounds faithfully the system must be capable of transmitting frequencies as low as thirty cycles per second with fidelity.* In commercial practice, it has been found that a system which is capable of transmitting all frequencies in the range from 30 cycles per second to 4000000 cycles per second will give satisfactory reproduction.[2] This requirement of a very broad band of video frequencies places very stringent demands on the amplifiers employed and, for wired television, on the transmission line used.

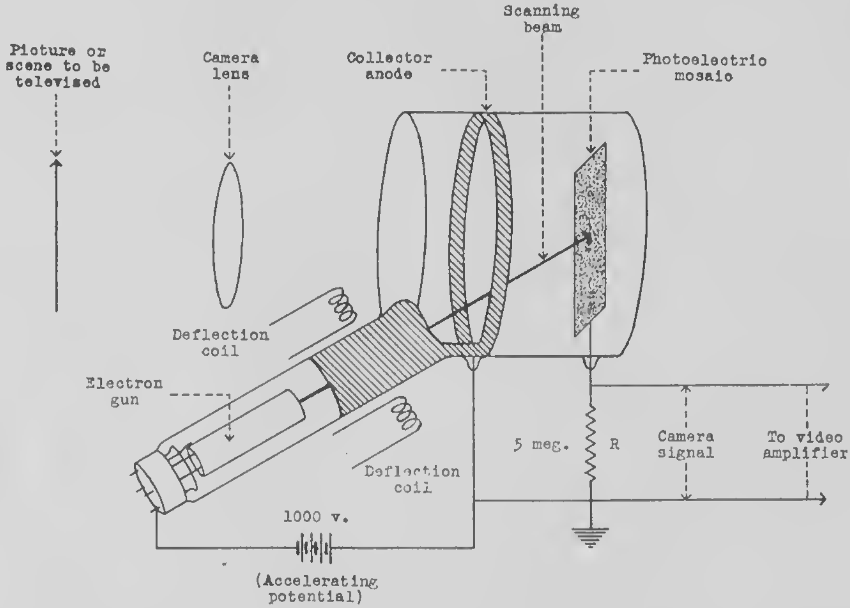
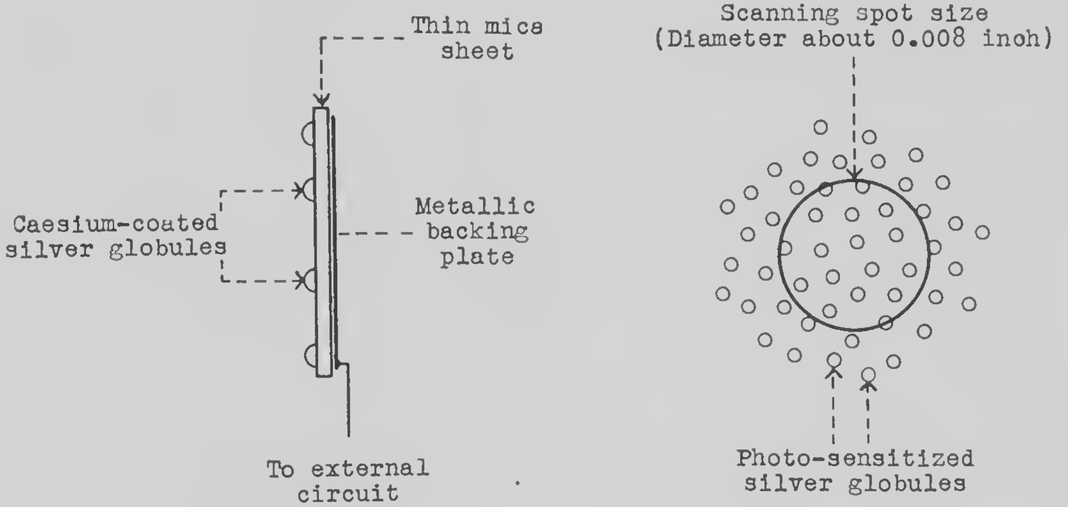


Fig. 2—Construction of an iconoscope tube.

In early experiments in television the picture was scanned by mechanical means

2. It will be seen by reference to Fig. 5 that the "picture wave" transmitted is far from a sinusoidal wave. This complex wave can always be analyzed into a Fourier series. In practice, it is found that the complex wave is transmitted with satisfactory fidelity if the system is capable of transmitting all components of the Fourier series which lie within the frequency range specified above.

but in present day practice, electronic scanning is always employed. The electron tube used to accomplish this electronic scanning is known, in general, as a *camera tube*. While several types of camera tubes have been developed one type only, namely, the *iconoscope*[3] (Greek: eikon, image and skopos, a watcher) will be described here. The construction of the tube is shown in Fig. 2. The optical part of the system consists of a camera lens which focuses a real image of the picture or scene to be reproduced on a photoelectric mosaic screen in the iconoscope tube precisely as the lens of an production of the original picture. The next essential part of the iconoscope tube is the electron gun which is simply the source of a sharply focused high-velocity beam of electrons directed toward the mosaic screen and known as the scanning beam. The size of the scanning spot is the cross-sectional area of this beam. This beam may be deflected in a vertical direction by means of the magnetic field due to a current flowing through the pair of deflection coils shown in Fig. 2 and may be deflected horizontally by means of a second pair of coils (not shown in the diagram) placed at right angles to the



(a) Structure of mosaic screen.

(b) Magnified detail of mosaic.

Figure 3

ordinary camera forms a real image on the photographic film. The structure of the mosaic is shown in some detail in Figs. 3(a) and 3(b). It consists essentially of a thin sheet of mica on which is deposited a very large number of very small globules of silver on each of which has been deposited in turn a thin layer of caesium in order to obtain high photoelectric sensitivity. Each globule acts as a very small photoelectric cell and each is completely insulated from its neighbors. When the image of the picture is thrown on the mosaic screen each globule emits photoelectrons and, therefore, acquires a positive charge in direct proportion to the intensity of illumination of the globule. It follows that the charge distribution over the surface of the mosaic is an electrostatic re-

first pair. A horizontal scanning generator supplies variable current to the horizontal deflection coils such that the scanning beam sweeps horizontally back and forth across the mosaic screen at the desired rate. A second scanning generator supplies independent variable current to the vertical deflection coils which causes the scanning beam to move, simultaneously with the horizontal motion, from top to bottom of the picture and back to the top at the desired rate. These deflecting currents are varied in such a manner that the path followed by the scanning beam is that shown in Fig. 1. Actually, provision is made for supplying a retarding voltage to the electron gun from the scanning generators such that the scanning beam is cut off during the horizontal return from

3. Invented by Dr. V. K. Zworykin in 1925. The other important type of camera tube is the image dissector invented by P. T. Farnsworth in 1931.

right to left and during the vertical return from bottom to top, i.e., the mosaic is scanned by the electron beam only as the beam moves from left to right and only as it progresses from top to bottom of the picture in keeping with Fig. 1. The sweep rates are chosen so that the mosaic screen is scanned in approximately 485 active lines and is completely scanned 30 times per second. As the scanning beam sweeps over each globule of the mosaic the effect is to restore the negative charge which the globule has lost by photoelectric emission. It may be shown that as a result of this restoration of charge an instantaneous electric current flows from the mosaic screen through the resistor R to the collector anode (see Fig. 2) of the iconoscope the magnitude of this current depending on the total charge restored to the globules being scanned at that instant. This in turn depends on the intensity of the light falling on these particular globules. Hence, the basic condition for electrical transmission has been satisfied, namely, an electric current has been obtained the instantaneous value of which is proportional to the brightness of the picture element being scanned at that instant.

It is now desirable to consider the essential parts of a complete television transmitter (for wired television). These are shown in Fig. 4. The operation of the iconoscope has already been explained. The video frequency waves resulting from the scanning of the mosaic screen of the iconoscope are amplified by a video frequency amplifier identical in principle with the audio frequency amplifiers of radio receivers, public address systems, etc., but considerably more complex in detail because of the very broad band of video frequencies (30 cycles per second to 4 million cycles per second) to be amplified. The scanning generators, horizontal and vertical, control the scanning of the mosaic screen. Since it is essential that the picture be reproduced by the receiver in exact synchronism with the scanning of the original picture by the transmitter it is necessary to transmit synchronizing pulses as well as the video frequency picture waves. These pulses are generated by the scanning generators and are added to the picture signals in the mixer circuit shown. This mixed signal is transmitted over a suitable transmission line to the receiver. An ordinary telephone line is not suitable since high frequencies are radiated from an open-wire line as from an antenna. This difficulty is eliminated by the use of coaxial cable but the cost of this cable places a very practical limit on the development of wired television.

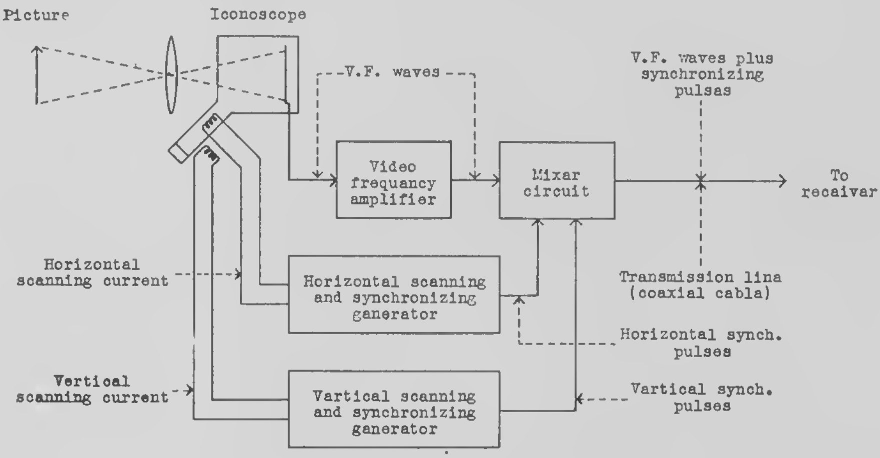
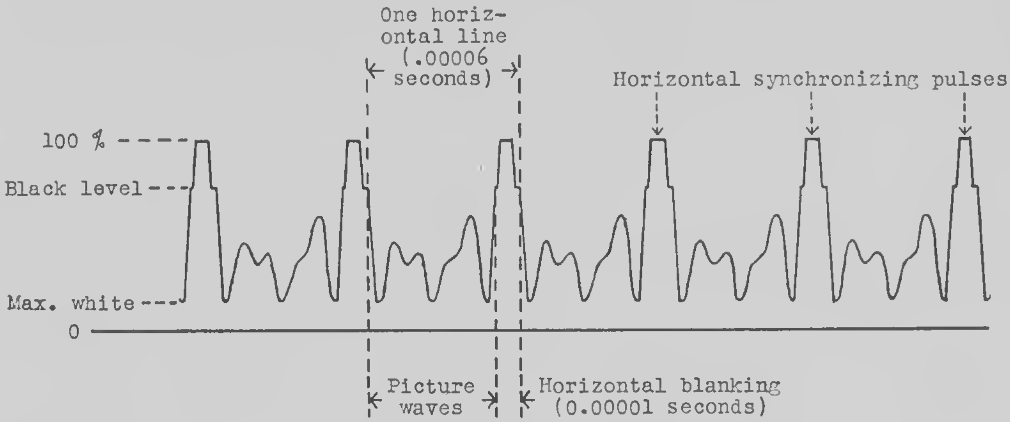


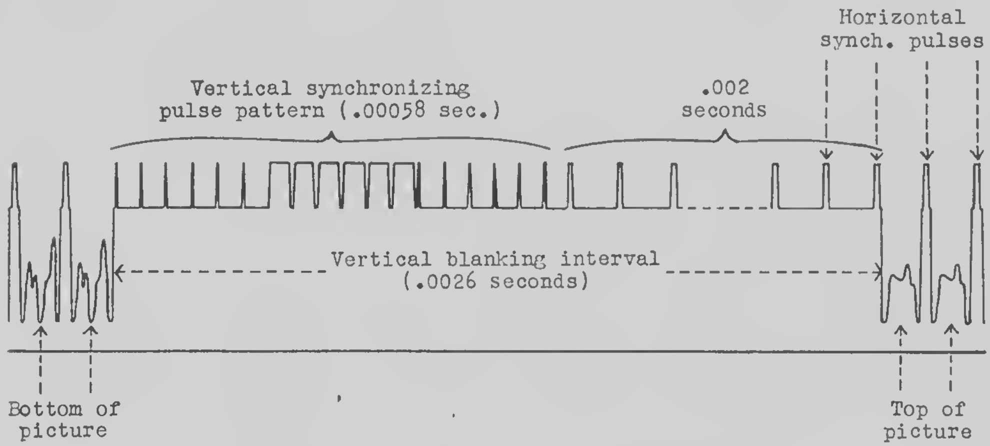
Fig. 4—Block diagram of television transmitter (wired transmission)

The nature of the complete wave transmitted is shown in Fig. 5. The curve of Fig. 5a shows the wave transmitted as the scanning beam moves back and forth across the picture working from top to bottom. It will be noted that a negative wave is transmitted, i.e., the brighter the spot scanned the smaller the transmitted current. During the interval marked "Picture waves" the scanning beam is active and moving from left to right across the picture. Information as to the brightness of the picture element being scanned at any instant is conveyed to the

receiver by the depression of the transmitted wave below the "Black level". During the return from right to left across the picture the scanning beam is cut off and in this "horizontal blanking interval" a single synchronizing pulse is transmitted which conveys the information to the receiver that the picture (the horizontal sweep continuing at an unchanged rate during this interval). During the first quarter of this "vertical blanking interval" a very definite complex pattern of pulses (see Fig. 5b in which the time scale is compressed as compared with Fig. 5a) is transmitted which conveys the



(a) Wave transmitted during horizontal scanning



(b) Wave transmitted during vertical return of scanning beam (compressed time scale)

Figure 5

scanning beam is returning to the left side of the picture. Since this horizontal synchronizing pulse lies entirely above the black level it does not interfere with the picture transmission in any way. When the scanning beam reaches the bottom of the picture there is a considerable interval (about 1/390th of a second) during which the scanning beam is inactive while it returns to the top of the information to the receiver that the scanning beam is returning to the top of the picture. During the remainder of the vertical blanking interval horizontal synchronizing pulses are transmitted as during the actual scanning of the picture but during the whole time of the vertical return the transmitted wave stays at or above the black level. By

(*Continued on Page* 45)

Modern Treatment of MENTAL DISEASES

by STUART SCHULTZ, B.A., L.R.C.P., M.R.C.S., M.D.
President of the Manitoba Medical Association

THE PEOPLE of Manitoba, and in fact all people, are becoming health conscious. There are few forms of disease more common than mental illness. It is more prevalent than cancer and the number of beds in mental hospitals closely approximate the combined number of beds in all other hospitals. The economic cost is staggering for several reasons. First, the patient is withdrawn from society and is no longer able to provide for his dependents. Second, if the patient is a mother, adequate supervision and care of her children must be arranged. Third, in many cases the home is broken up and the children become a charge of the State. In all cases there is disorganization of social and family life. Fourth, the cost of hospitalization demanding special scientific procedures under the supervision of trained personnel, is of necessity expensive.

The fundamental issue of all modern health programs today is the prevention of disease. Why should patients suffer psychic pain and mental anguish; why should individuals lose their liberty; why should homes be disorganized; why should there be loss of man and woman power; why should there be a staggering cost of special hospitalization? The answer to the above problcms offers a challenge to every thinking member of the community, and lies in a large measure in the field of preventive psychiatry.

The first problem is one of education. Mothers, fathers, teachers, preachers, and social workers must have an intelligent knowledge of the development of a child and the difficulties he must face in adapting himself to our complex social and economic order. Inadequate or abnormal development too often precedes the development of a psychosis.

We believe in the formation of pre-natal clinics so that the mother's health is preserved throughout pregnancy and labor, and the child is born without injury. By careful supervision of the patient's diet, activities, blood pressure and urinalyses the physician can reduce maternal and infant morbidity and mortality. One has just to see a child with spastic paralysis or defective intellect to realize the importance of ante-natal care.

Mental and physical development of a child must be considered as an entity. The mental growth as well as physical, commences with limb and body movements while the child is in utero. The development progresses so rapidly and completely that even a child born at seven months has an excellent chance of survival. During early infancy, patterns of perception and manipulation undergo rapid organization. In the first eighteen months of life, it has been stated that the child learns more of the outside world and of his own nature than he acquires all the rest of his life. "It is in childhood that the mind is most open to impressions and is readily kindled by the first spark that falls into it." There is an old Arabian proverb which says, "A fig tree looking on a fig tree becometh fruitful." A child learns by simple imitation; example is more than precept, it is precept in action. Certain homes have a detrimental influence on a child's development, such as domination by a ritualistic mother or a tyrannical father. Over-solicitude and over-protection are as potent factors in this regard as are poverty and neglect.

Every care should be taken to ensure the child's good health. Early immunization for diphtheria, scarlet fever, chickenpox and typhoid fever, in most cases will eliminate these debilitating diseases, with their many

harmful sequelae. Careful examination of the pre-school and school child with adequate remedial measures, will eliminate such defects as diseased tonsils, carious teeth or other foci of infection, and will pay dividends in future lives of physical and mental vigour.

The modern child-guidance clinic plays an active part in the normal development of a child from conception to maturity. Emphasis is now laid on the normal and above normal, rather than on the unfortunate, retarded child. Child guidance is the study of how a child thinks, feels and acts, and his resultant behaviour. The clinics can operate most effectively by making use of school organizations, as for seven hours a day the child is under intelligent supervision and direction. It is of value to estimate the child's intelligence on entering school so as to determine whether he can or cannot cope with grade One work, and in the second place to forecast his rate of progress. If the child has a normal intelligence quotient he can take all grades in public and high schools at the rate of one grade a year. However, if he is retarded with an intelligence quotient of 70%, then in our opinion grade Four is his maximum grade. He will attend school from six to fourteen, that is a period of eight years, and it is most essential that he should spend two years in each grade, and if he does so he can become a good grade Four student. If he is pushed along too rapidly then he feels that he cannot cope with his school work, becomes indifferent, develops feelings of inferiority and often develops problems of behaviour. On the other hand, a child with above normal intelligence has a right to proceed at a more rapid pace, and unless allowed to do so he may find so much idle time on his hands that he may develop problems of behaviour. Even more important than this, as he does not make an hundred percent effort he will develop careless methods of thinking and exhibit an inadequate pattern of study. The mental tests we have found most effective are the Binet-Simon, the Bellevue Adult and the Minnesote Biphasic Personality tests. We have found that the use of psychometric examinations and the treament of behaviour problems to be a definite contribution to preventive psychiatry.

The child with a speech defect, while above average intelligence as a rule, very often does a poor quality of work on account of emotional instability and feelings of inferiority. Such speech defects become apparent when a child commences school or during the period of puberty. Our clinics, assisted by mothers and teachers, have found speech re-training to produce dramatic results, both in articulation and in the development of self-assurance and self-confidence.

The child may come into conflict with his parents in early puberty. Up to this age the child is amenable to home influences and parental authority. After this age, partly due to sexual and intellectual maturity, he acquires a desire for self expression. "The world has progressed, new ideas are abroad, new influences are at work to which parents are not susceptible, but which profoundly influence the younger generation." The parents look upon the child as being disobedient and rebellious, while the child looks upon the parents as old fashioned and ignorant. Wisdom and understanding on the part of the parents is necessary to harmonize conflicting ideas and bridge the gap between boyhood and manhood.

The establishment of adult out-patient clinics has been an important factor in the mental health of the community. As a rule the patient consults the psychiatrist in the early stages of his illness. He arrives at a better understanding of the nature of his illness and his own ability to deal with it. This is important, as early diagnosis and treatment offer the best hope of recovery.

When an active psychosis develops it is advisable for a patient to enter a mental hospital. He may come in as a voluntary admission, a general admission with medical certification, or as a commitment by a Magistrate. The entrance to hospital withdraws the patient from the environment in which his psychosis has developed. In many cases such environment has included over-solicitude by relatives on the one hand, or irritating contacts on the other. The patient now receives a complete physical, including serological tests and X-ray examination. A history including both family and personal is taken, with careful attention being given to the patient's early development, personality, education and marital state. A thorough investigation is carried out as to the cause and development of the present illness and an interpretation is made of the outstanding features. The case is then presented before a staff conference including psychiatrists and other officers, so that a composite view can be secured. Diagnosis and treatment are recommended.

The patient is placed on a definite routine which ensures adequate supervision, nutrition, rest and activity. Supervision is required as many patients are suicidal or violent and must be protected from injuring themselves or others. Nutrition is an important factor as many patients refuse to eat and it is necessary to feed them by means of a tube. Many patients are over-active and require sedation to prevent them from reaching a stage of exhaustion. Adequate rest can be secured by the careful use of such hypnotics as hyoscine, morphine, nembutal and ortal sodium.

Activity therapy and recreation are useful in helping the patient to regain his physical and mental vigour. He first enters formal occupational classes where he makes articles which appeal to him. For example, the men make toys, small articles of furniture or work at printing. Female patients, on the other hand, have needle work, knitting, sewing and weaving. From these classes the patient graduates to the kitchen, laundry, and the Nurses' Home. We feel that work, and by work we mean real work, is a definite therapeutic agent, and during the past year over a hundred patients worked out daily on the farm. The value of small articles sold was over $5,000, and the value of farm produce was over $30,000. The actual figures are mentioned, not because of the economic value, but simply as integers as to the amount of work performed. Recreation plays an important part in the readjustment of the psychotic patient, by awakening his interest in his surroundings, by social contacts and by activity. Picture shows are held weekly and dances twice monthly during the inter months. Curling and skating are enjoyed in winter, and in the summer football, softball and tennis.

We shall now deal with special treatments, and in this regard I wish to mention Shock Therapy. Insulin Shock Therapy has been carried on in our hospital since October 1937. Under this treatment a patient receives insulin by hypodermic, and if the dosage is sufficient the patient passes into a semi-coma or comatose state. He is roused from this condition by the giving of syrup through a nasal tube or glucose by the intravenous method. This has been a very effective method of treatment, the patient gaining thirty pounds in weight, the period of hospitalization being greatly reduced and the recovery rate being increased. This method is valuable in the treatment of Schizophrenia.

Convulsive Shock Therapy in the form of Metrazol was introduced in 1937 in Manitoba. The method consists of giving Metrazol intravenously, with the production of epileptiform seizures with tonic and clonic convulsions, during which time the patient is unconscious. This form of therapy has been replaced by Electric Shock Therapy, which was introduced in January 1942. Areas over the temple part of the skull are shaven and a pad immersed in a saline solution is placed over this area. Electrodes are then applied, the resistance of the patient is measured, and then sufficient electric current is passed through the electrodes to produce the epileptiform convulsion. This method is simple, easily controlled, painless, and there is no apprehension on the part of the patient. Convulsive Shock Therapy is valuable in the treatment of depressions of the Manic Depressive group.

There has been marked improvement in the care of epileptics. The former method of treating these patients with bromides resulted in skin eruptions and rapid mental deterioration. A combination of barbiturates, with or without Dilantin, is now used to control seizures and these drugs do not cause deterioration. In the condition known as 'Status Epilepticus' one seizure follows another with little or no interval between them. Nembutal given intravenously has been found effective here.

The Parkinson Syndrome, which follows encephalitis lethargica or sleeping sickness, has been found to respond to a drug known as Rabellon which consists of the root of Belladonna. The patient suffers from a mask-like facies, tremor, rigidity and muscular cramps. In practically all cases there is alleviation of symptoms.

General paresis, which is due to syphilis of the nervous system, now receives adequate treatment. The disease follows the initial infection at a period from three to twelve years. Malaria is induced by the injection of blood containing the malarial parasites. The patient is allowed to have from twelve to fourteen chills, the temperature rising to 105° and then the malaria is stopped by the administration of Quinine. This is followed up by twelve months of treatment with Mapharsen, Tryparsamide and Bismuth.

The most recent advance in psychiatry is a form of brain surgery known as Prefrontal Leucotomy. The operation consists

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A PEEK AT MODERN ALGEBRA

by HERSHEL NITIKMAN, (B.Sc. '44)

THE TIME has long past when a nodding acquaintance with a first course in Calculus is sufficient mathematical equipment for a research scientist. One by one, various branches of advanced pure mathematics, originally developed with no thought or intention of application to scientific investigation, have become part of the required knowledge of the serious student. One of the newest to be applied is Modern Abstract Algebra. Probably the most important subdivision is the theory of Groups. Originally developed late in the 18th century, its first important application was by Galois early in the last century in investigation of the fundamental problems of algebraic equations. Its logic is so general that it is now applied in the widest variety of modern fields of research. It is a powerful weapon in the Quantum theory, Atomic Physics, the study of Differential Equations, Electrical networks, Chemical combinations, Philosophy, and wherever mathematical tools involve the Theory of Transformations (including Statistics, Tensor and Vector Analysis and Conformal mapping). Every one of these finds group theory a shortcut in the discovery of fundamental new theorems. Besides its practical value, its elementary theory throws so much light on the basic mathematics we have all learned to accept without thinking about, that it is well worth while to discover its whys and wherefors.

In elementary algebra we are concerned with the study of real numbers and their *combination* in what are technically called *binary operations* so that two numbers so combined will give a third real number. The two forms of combinations defined for the real numbers of elementary algebra are addition and multiplication. These we indicate respectively, and variously by $a+b$ ab, axb, a^ob. Further, these laws of operation are distinguished by no Divine Guidance, nor can they be "proved" to be the properties of the real numbers: The rules governing addition and multiplication can be stated explicitly and generally for general elements a, b, c, . . . etc. Other rules are definitely conceivable, and indeed are very commonly used in higher mathematics.

The fundamental type of mathematical system defined by the binary operations of its elements is the *Group*.

A set of elements form a group if there exists a well-defined binary operation, denoted ^{o}, such that for elements a, b, c, ... of the group, the following axioms hold:

(1) $a \circ b$ is also a member of the group.

(2) $(a^ob)^oc = a^o(b^oc)$ . . . the associative law

(3) one of the elements, often denoted I, has the property that $a^oI = a$, for all 'a'. I is called the *identity* element.

(4) for every 'a' in the group, there is an inverse element a^{-1}, such that $a^oa^{-1} = I$.

To make these definitions clear, we look at a common example. Take the integers, with the operation being addition.

(1) The sum of 'a' and 'b' is also an integer.

(2) The order in which the operation is applied to several elements is immaterial, e.g. $(4+5)+2=9+2=11=4+(5+2)=4+7$.

(3) 0 is the identity element, for $a+0=a$ for all integers 'a'.

(4) And finally, for every integer there is an inverse integer, -a and $a+(-a)=0$.

We have proved that the integers under the operation of addition form a group, and we now know that anything we can prove for a group in general is also true for this common example.

Now, if the operation is such that $a^ob = b^oa$, then the group obeys the commutative law, and is called a commutative or Abelian group. The integers under addition are an Abelian group. Those who know something about vector analysis will recall that the x-product of two vectors is non-commutative, since, $AxB = -BxA$; in the Algebra in which each possible transformation of co-ordinates is an element, or in the similar algebra in which *matrices* are elements, (which contains the algebra of real and imaginary numbers as a special case) the multiplication may or may not be commutative. It does not have to be.

If corresponding to an element d, there exist positive integers n, m, . . . such that $a^n = a^m = I$ then the least such integer is called the order of a.

Now that we have defined the order of an element, we can use it in a simple theorem.

Thm. If every element of a group is of order 2, the group is an Abelian group. i.e. if for every a in the group, $a^n=I$, then it follows that for any a and b in the group $a^ob = b^oa$. Simple? Of course! Trivial? No Siree! . . . . here's how: . . . . . .

Proof:

$$
\begin{aligned}
(b^oa)\,o\,(a^ob) &= b^o(a^oa)^ob && \text{by (2)}\\
&= b^o(I)^ob && \text{by hypothesis}\\
&= b^ob && \text{by (3)}\\
&= I && \text{by hypothesis}\\
\therefore\quad (a^ob) &= (b^oa)^{-1} && \text{by (4)}\\
\text{But } (b^oa)\,o\,(b^oa) &= I && \text{by hypothesis}\\
\therefore\quad (b^oa) &= (b^oa)^{-1} && \text{by (4)}\\
\therefore\quad a^ob &= b^oa
\end{aligned}
$$

So, if every element of a group is of order 2, the group is commutative. Of course, the converse is not true.

One reason for including this very simple theorem is to show the necessity for absolute care in a sound proof. $ab=ba$ is an unusual phenomenon, not possessed by very many algebras, and every single step in the proof was essential.

Now, it is easily shown that the real number system of our every day algebra is defined completely in terms of these purely arbitrary Group Properties. First we define a fairly general algebraic system, from which we may define many special cases, called the Field.

Def'n. A field is a system, F, of elements having defined for it *two binary operations* which we will call *addition* and *multiplication,* so that:

1. under addition F is a commutative group with an identity element we choose to denote 0.
2. under multiplication, all the elements of F except 0 form another commutative group.
3. mutiplication is distributive under addition, i.e. $a(b+c)=ab+ac$ for all a, b, c, in F.

We see in the field, as above defined, many of the properties of the real number system. Nothing true of a field is untrue of the classical algebraic system—so we may investigate many fundamental properties of the algebra of the real numbers by the less cumbersome theory of the general Field. Here are a few fairly natural definitions:

Def'n. A set of elements is called *ordered* if we introduce the restriction that any given element 'a' must be so related to any other element 'b' of the set that either one of three possibilties must be true:

1. $a>b$; 2. $a=b$; 3. $a<b$. It will be noted that this property was not assumed for either the field, or the even more general Group.

Def'n. A *subset* 's' of a set S, is a set of elements consisting *only* of elements found in S.

Def'n An ordered set is called complete if, and only if, on every division of *all* elements of the set into two subsets A and B, such that every elemnet of A is $<$ every element of B and every element of B is $>$ every element of A, there exists:

either an element of A $>$ every other element of A

or an element of B $<$ every other element of B.

This leads to the statement that there is only one *complete ordered Field.* All fields which are complete and ordered differ only in notation. THE COMPLETE, ORDERED, FIELD IS THE REAL NUMBER SYSTEM OF CLASSICAL ALGEBRA.

There is, fortunately, no space for a proof of this statement, but it is a standard theo-

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MAN of VISION . . .
Humphry Davy

by F. ALLAN JOHNSON, (Hon. '45)

Winner of Petrie Medal '44

HUMPHRY DAVY was borne in Penzance on December 17th, 1778, the first son of a middle class wood carver, Robert Davy. At an early age Humphry began to show signs of that ability which so remarkably distinguished him in later life. At the age of two he could speak fluently and at the age of five he could read very rapidly, and remained a notably swift reader afterwards. At eight he was deeply interested in ghost stories and superstitions. He never lost superstitious practices; for example, when he travelled in Europe at the height of his fame he astonished friends by insisting that they should cross their knives and forks after finishing a course. He possessed a remarkable memory, and was singularly rapid in acquiring knowledge from books. He was especially attracted by the *Pilgrim's Progress* and he delighted in reading history. He was a clever boy but by no means a prodigy.

In his youth he was described as a rather uncouth little fellow, very fond of play but not very fond of work, but even then a keen angler. The only indication of the future chemist was his predilection for making "thunder powder" and fireworks. He grew into a bright but awkward lad, narrow-chested and round shouldered. He had an impediment in his speech and although it was not very serious, he tried to overcome it by following the example of Demosthenes, in that he would go down to the shore and practice speaking aloud. He did overcome the defect to a considerable degree, but the result was apparent in after years, when he formed a habit of speaking in public with a peculiar intonation which seemed strange to his audiences, and which was very often mistaken for affectation.

After an elementary education in various schools, Davy attended Truro Grammar School which he left in December 1793, just before he was fifteen. For the next year he continued in the "enjoyment of much idleness". After his father's death in 1794 Davy

SIR HUMPHRY DAVY

realized the necessity of setting to work seriously; he decided to enter the medical profession and in February 1795 was apapprenticed with Bingham Borlase, an apothecary and surgeon, practising in Penzance. He then threw himself into the task of self-improvement with irresistible ardour and began a course of extensive reading.

covering nearly all branches of learning. Following out his prescribed course of study, not quite in the prescribed order, however, he reached the subject of chemistry in January 1798. His text-books were Lavoisier's *Elementary Chemistry* and Nicholson's *Dictionary of Chemistry*. He kept up the study of mathematics during the whole course, having begun in 1796, for he remarks on its usefulness as a preliminary to the study of chemistry and physics. In his self-imposed task of mastering chemistry, he at once began practical work, having fitted up a small laboratory furnished with the very simplest and most inexpensive apparatus, such as wine glasses and tobacco pipes.

While in the service of Mr. Borlase, Davy made the acquaintance of two visitors in Penzance, Gregory Watt, a son of the great engineer, and Davies Gilbert. The latter recommended him to Dr. Beddoes, a medical man and Professor of Chemistry at Oxford. Thus four months after beginning his chemistry studies, Davy was in correspondence with Dr. Beddoes in Clifton, Bristol. This correspondence with Dr. Beddoes was fraught with momentous consequences, for it led in 1798 to his being offered the position of superintendent of the Pneumatic Institution at Clifton, founded by the doctor with the help of Josiah Wedgewood and Gregory Watt, with the object of experimenting with various recently discovered gases in order to ascertain whether they would prove suitable as remedial agents. He accepted Beddoes' invitation to Clifton on the understanding that he would be able to acquire clinical experience during his work for the Pneumatic Institution, for Davy did not abandon his intention to graduate as a medical doctor until the age of twenty-nine, and had already for two years been one of the secretaries of the Royal Society, during which time he was registered as an undergraduate and kept terms at Cambridge. In his work at the Institution, he discovered, amongst other things, that nitrous oxide was perfectly respirable but produced absolute intoxication, and he suggested its application in surgical operations, but no notice of this suggestion was taken for half a century. In 1800 he published the result of his investigations under the title *Researches, Chemical and Philosophical, chiefly concerning Nitrous Oxide or Dephlogisticated Nitrous Gas, and its Respiration*. This book made the reputation of Davy.

Soon afterwards, Davy was recommended for the lectureship at the Royal Institution in London, which had been founded a few years previously by Count Rumford. He settled the terms of his engagement satisfactorily in January 1801 and was appointed Assistant Lecturer in Chemistry, Director of the Laboratory, and Assistant Editor of Journals, with the allowance of a room, coal and candles for lodging, and a salary of one hundred guineas per annum.

Rumford was not immediately impressed by Davy's personality and manners, and had him lecture in a small theatre as a test. After hearing him speak, he exclaimed "Let him command any arrangements which the Institution can afford." So brilliantly did Davy discharge his duties that his audience was taken by storm and the lecture room was soon filled with enthusiastic listeners. The full title of lecturer was given him at once, and the *Philosophical Magazine* predicted that "from the sparkling intelligence of his eye, his animated manner and the 'tout ensemble', we have no doubt of his attaining a distinguished eminence." As a result of his popularity he was promoted to be Professor of Chemistry at the Royal Institution in May 1802.

The variety of Davy's duties prevented him from concentrating on electro-chemistry during the first years at the Institution. He was elected to the Royal Society of London in 1803, though he had published only one paper in their *Transactions*. He received the Copley Medal, the Royal Society's highest honour, in 1805, for his researches in the chemsitry of mineralogy.

Davy's enthusiastic interest in electro-chemistry led him to describe its state and add his own contributions to the subject in a paper to the Royal Society, *On some Chemical Agencies of Electricity*, which was made the Bakerian Lecture of the year, the Royal Society's chief annual lecture on physical science. The sensation which the paper created in England was great; its effect abroad may be judged from the fact that the French Academy recommended Davy as first recipient of the gold medal and three thousand francs, promised by Napoleon for "the best experiment that should be made in each year on galvanic fluid." This recognition had a special value, owing to its being bestowed in the face of bitter political hostility between France and England, then at war with each other.

During 1807, Davy continued his electro-chemical researches. In his first Bakerian lecture in 1806, he had plainly stated that he expected that no chemical compound would

be able to withstand the decomposing effects of electrical machines of sufficient power. As early as 1800 he had followed Henry in the attempt to decompose potash by electricity, but found that the solution of potash was merely made stronger at one of the poles by the action of the current. In fact he succeeded in decomposing nothing but the water. In 1807, he returned to the problem of the composition of potash and soda. He suspected that these substances could not be elements, partly by analogy with ammonia, which contained hydrogen and nitrogen. Perhaps in the denser alkalis, such as potash, the hydrogen might be replaced by a denser substance, such as phosphorus or sulphur. No combination of these substances with nitrogen were known, so "it was probable that there might be unknown combinations." The possible existence in potash of an element heavier than hydrogen was Davy's significant and sufficient inspiration.

On October 6th, 1807, he used a new method of attack "the presence of water appearing thus to prevent any decomposition" said he "I used potash in igneous fusion". To his great surprise, he noticed intense light at the negative pole and a column of flame rising from the point of contact. When he reversed the current, the flame always came from the negative pole. Since perfectly dry potash is a non-conductor, Davy gave it a brief exposure to the air. He said, "under these conditions a vivid action was soon observed to take place. The potash began to fuse at both its points of electrization. There was a violent effervescence at the upper surface; at the lower, or negative surface there was no liberation of elastic fluid; but small globules having a highly metallic lustre and being precisely similar in visible characteristics to quicksilver appeared, some of which burnt with explosion and bright flame as soon as they were formed, while others remained and were merely tarnished. The globules were finally covered with a white film which formed on their surfaces. Numerous experiments soon showed these globules to be the substance I was in search of, a peculiar inflammable principle, the basis of potash." Because he had obtained the metal from potash, he named it *potassium.* Sodium was discovered in a similar manner a few days later.

It still remained for him to prove the elementary nature of these metals, however, for many chemists believed them to be compounds of the alkali and hydrogen. Gay-Lussac and Thenard argued, for example, that since ammonium = ammonia + hydrogen, so potassium = potash + hydrogen. It was finally proved that no hydrogen can be evolved from potassium and that Davy was correct in regarding sodium and potassium as elements. The results of Davy's researches were published in the *Philosophical Transactions* of 1807, and formed the subject of the Bakerian Lecture to the Royal Society on November 19th of that year. Davy's first Bakerian lecture had made a strong impression on the learned world, but the second made an enormous impression. The new substances he had discovered were themselves so exciting. The general opinion of posterity is, however, that while the second lecture was more spectacular, the first was more fundamental.

While Davy was experimenting and writing in the extremest excitement, during the days before November 19th he became feverish. He redoubled his exertions from the fear that he might die before his descriptions were finished. After his lecture was delivered, he collapsed into a serious illness and took to his bed on November 23rd. At the extreme height of his fame, Davy lay near death. Bulletins were issued, similar to those of princes, and his illness even increased his popularity; eminent specialists refused to accept fees for attending him. While he was convalescing, public sympathy was converted into subscriptions for the construction of large Voltaic batteries.

During the next two years after his recovery, Davy discovered a number of new substances and made determined attempts to decompose nitrogen. His Bakerian Lectures for 1808 and 1809 were first class, but did not contain fundamental discoveries equal in importance to those described in his earlier Bakerian Lectures. They displayed his weakness in systematic work, and his admirers were disappointed. The Royal Society had acquired the habit of inviting him to give their chief annual lecture on physical science, so he had to make it an interim report on his researches when there was no fundamental discovery to announce.

Davy's next research was on muriatic and oxymuriatic acids. In 1808 he announced the view that "muriatic acid gas is a compound of a substance which as yet has never been procured in an uncombined state, and from one-third to one-fourth of water, and that oxymuriatic acid is composed of the same substance (free from water) united to oxygen". His idea was that "when bodies are oxidated in muriatic acid gas, it is by

a decomposition of the water contained in that substance, and when they are oxidated in oxymuriatic acid, it is by combination with the oxygen in that body." This was essentially the view of Lavoisier and the French school, who regarded oxymuriatic acid as oxidised muriatic acid. Davy believed that all muriates (chlorides) contained oxygen. In 1809, however, he ignited charcoal to white heat in muriatic and oxymuriatic acids and observed that no action occurred and he began to doubt whether or not these bodics really contained any o: ygen. In a paper read on July 12th, 1810 he sought to show that oxymuriatic acid was an element, and that muriatic acid gas was a compound of oxymuriatic acid and hydrogen. He said: "Few substances, perhaps, have less claim to be considered as acid than oxymuriatic acid . . . May it not in fact be a peculiar acidifying and dissolving principle, forming compounds with combustible bodies, analogous to acids containing oxygen, or oxides . . . ?" On this idea muriatic acid may be considered as having hydrogen for its basis, and oxymuriatic acid for its acidifying principle". He thus overturned the oxygen-acid theory and demonstrated that muriatics were compounds of metals with oxymuriatic acid. In his Bakerian Lecture for 1810, entitled *On some of the combinations of oxymuriatic gas and oxygen, and on the chemical relations of these principles to inflammable bodies,* he gave further proof of the elcmentary nature of oxymuriatic acid. He concluded that "To call a body which is not known to contain o: ygen, and which cannot contain muriatic acid, oxymuriatic acid, is contrary to the principles of that nomenclature in which it is adopted; and an alteration of it seems necessary to assist the progrcss of discussion, and to diffuse just ideas on the subject", and he therefore proposed for the gas the name *Chlorine* because of its colour. Davy accurately defined a chemical element as a substance that could not be decomposed by any known chemical process, and he showed that chlorine was an element in this scnse and that it did not contain oxygen. This research is considered by chemists to be his finest exhibition of chcmical technique. The conclusions of Davy were at first doubted but when iodine and bromine wcrc discovered, all opposition disappeared.

The year 1812 brought two important evcnts into Davy's life: on April 8th he was knighted by the Prince Regent, an event to which he attached importance, as a recognition of the value of scientific research, and on April 11th he married Mrs. Apreece, a rich and fashionable widow. Shortly afterwards, he informed the managers of the Royal Institution that he could not pledge himself to continue his lectures, but was prepared to retain his position as Professor of Chemistry and Director of the Laboratory without salary. This offer was acccpted and his last coursc of lectures at the Institution were announced in that year.

Old New

DAVY LAMP

The presence of explosive gas is indicated by the burning of the fire damp in the interior of the gauge cylinder, the heat is conducted away, and prevents the flame from spreading to the gas in the mine.

Davy resigned the professorship at the Royal Institution in 1813, becoming honorary professor, and during the late autumn set out ,accompanied by his wife and Faraday as his "assistant in experiments and writing" on what he called a "journey of scientific enquiry" to the continent. Special permission was obtained from Napoleon, who undoubtedly had a high opinion of Davy, to pass through France, then at war with England, on the way to Italy. Hc was received with great honour in Paris, where he attended the meetings of thc Imperial Institute which elected him a corrcsponding member of the first class on Decembcr 18th.

During November 1813, Ampere presented to Davy a small quantity of a "substance X" discovered in 1811 by a soap manufacturer, Courtois, in the liquor from the lixiviation

of kelp. On November 29th, a paper was read to the French Academy of Science on this new and remarkable substance discovered by Courtois, which when heated, gave a violet-coloured vapour. This was followed a week later by a communication from Gay-Lussac. pointing out its analogies to chlorine and bromine, and proposing the name "iode" for it. It is characteristic of the impetuous manner in which Davy rushed through a research that, having obtained a small quantity of the substance, he at once set to work, and on December 20th a letter, in which he described his experiments, was submitted to the Academy by Cuvier. After a few days he forwarded his complete results to the Royal Society, proposing the name of *iodine* as the English equivalent for the new substance. Davy's work, however, was much more advanced than that of Gay-Lussac's. Gay-Lussac still regarded chlorine as oxymuriatic acid, and supposed this new "substance X" to yield an acid identical with muriatic acid. Davy, on the other hand, pointed out that the "substance X" was an element analogous to chlorine, whereas Gay-Lussac thought that it was analogous to oxymuriatic acid and thus did not grasp its essentially elementary nature. Davy arrived at a true estimate of its nature and prepared many compounds of it. He communicated his discovery to Gay-Lussac, who by no means agreed with his conclusions; and it was not until considerable time had elapsed and the latter chemist had carried out his masterly researches on iodine and its compounds that he became convinced of the correctness of Davy's views. Thus Davy's achievement with the equipment of his travelling-box of apparatus was technically remarkable, but fostered much ill-feeling as the French chemists considered that he had stolen a theme which they had discovered and which they were examining.

After his return to England in April 1815, Davy spent more and more time at country house parties where he thoroughly enjoyed fishing and shooting. He visited his wife's relative, Sir Walter Scott, and strained to establish his position as an aristocrat. Within three years his marriage had proved a conspicuous failure. His wife had no children, and had no interest in domestic life. Davy's brother wrote that Lady Davy was "fitted to excite admiration rather than love, and neither by nature in herself nor qualified to impart, in the best sense of the term, happiness to others." "There was an oversight, if not a delusion, as to the fitness of their union," and "it might have been better for both if they had never met."

While his domestic happiness failed, his great public reputation was enormously extended by his invention of the miner's safety-lamp. In 1812, ninety-two men and boys had been killed in an explosion in the Felling Mine near Gateshead-on-Tyne. This and other explosions, prompted J. J. Wilkinson to form a society for the study and prevention of mine explosions. Wilkinson called at the Royal Institution, in the autumn of 1813 to invite Davy's co-operation. Davy acceded to the request with enthusiasm, and offered at once to visit some of the mines. Davy's researches showed that inflammable gases have definite ignition points, that of methane the chief constituent of the explosive gas (fire damp) of coal mines, being relatively high. He also showed that a flame can be extinguished by cooling, and cannot be propagated to an explosive mixture of gases through the mesh of a wire gauze, which conducts away the heat of the flame and prevents the unburnt gas from reaching its ignition point. By January 11th, 1816, after three months of research, he had embodied these results in a safety lamp, which consisted of an ordinary lamp encased in a cylinder of wire gauze. The lamp was adopted early in 1816 and was hailed with the greatest satisfaction by the public, as well as by those whose interest was bound up in the mines. Davy took out no patent for his invention, and in 1817, in appreciation of his great work, he was presented with a service of plate, valued at Twenty-five Hundred Pounds, by the owners of many important collieries. Davy's services to humanity were, indeed, valued so highly that on October 20th of the following year (1818) a baronetcy was bestowed upon him.

In 1820, upon the death of Sir Joseph Banks, who had presided over the meetings of the Royal Society for no less than forty-one years, Sir Humphry Davy received the highest honour which can be bestowed on a scientific man, by being elected his successor. In spite of his extreme desire to be a great president, Davy was not exceptionally successful. He mis-managed his social entertainments and fretted at the refusal of the governing class to allow more prestige to science and himself. He "sighed for patrician distinction in the chair of Newton", and prompted a distinguished colleague to comment: "Sir, we require not an Achilles

(*Continued on Page* 47)

The VELOCITY of LIGHT

by ISRAEL N. HERSTEIN, (Hon. '45)

SINCE the earliest of times, man has been interested in natural phenomena about him, especially so in those which affected his senses. It is thus natural that his curiosity should be aroused about light for, by this medium, he could see the world around and without his sight he could not survive.

But, with the passage of time, the more inquisitive began to wonder over and to postulate about light. Was it some mysterious fluid, which when it penetrated his eyes caused him to see? was its action instantaneous? and such similar queries.

Until fairly recently, however, the answer to the last question seemed obvious. To the ancients' minds it was utterly ridiculous that it required a definite interval of time for light to pass from the source to the observer.

The first person, however, to claim that the action of time was not instantaneous, and to prove his claim, was a Danish astronomer Olof Romer in the year 1676. While studying the eclipses of the satellites of Jupiter, Romer noted that there was a definite deviation of the observed times for eclipses of the satellites, from the predicted time. He moreover noted that this deviation was a function of the position of the earth in its orbit. Thus when the earth was in position 2, the time deviation was about 16 min. from that in position 1. Romer thus concluded that this time was the time it took for the light to traverse the extra distance across the earth's orbit. Knowing this distance to be about 186,000,000 miles, he calculated that the velocity of light

$$c = \frac{186{,}000{,}000}{960} = 187{,}000 \text{ miles/sec.}$$

But as sound and as valid as Romer's arguments were, they were not deemed strong enough to break open the shell of doubt which had so imbued people with the idea of instantaneity of light. But, in 1727, Bradley, an English astronomer, by using an absolutely different astronomical effect got results for the velocity of light which strongly validated Romer's work. Bradley noticed the apparent motion of the stars, explainable by the fact that the earth was moving. Because the observer was being carried along by the earth at a definite velocity, the telescope had to be tilted through a definite angle from the position it would be set at if the earth was not in motion. Knowing this angle a and the velocity of the earth, the velocity of light could be calculated from $c = v/\tan a$. Bradley obtained the result $c = 2.99714 \times 10^{10}$ cm/sec. (186,233 mi/sec.).

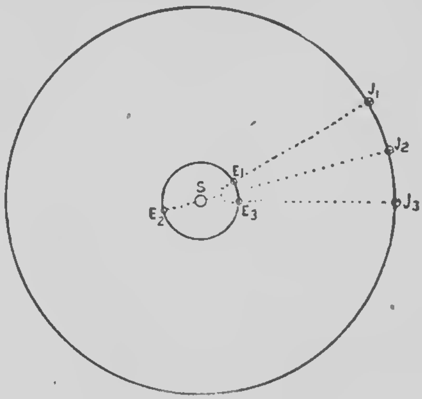

Fig. 1—Romer's Determination.

The results were in good agreement with Romer's and thus established that light did have a finite velocity. Due to the extremely great velocity it seemed unlikely that methods involving any distance but an astronomical one could be a means of measuring the velocity of light. Thus it

seemed unlikely that a determination could be made on the earth itself. The first to try this was Fizeau, a French physicist in 1849.

The obvious method is to measure the time taken for the light to travel a definite distance and calculate c. This was Fizeau's manner of attack. Using the apparatus (Fig. 2) Fizeau made several determinations of c. The principle of the apparatus was this:

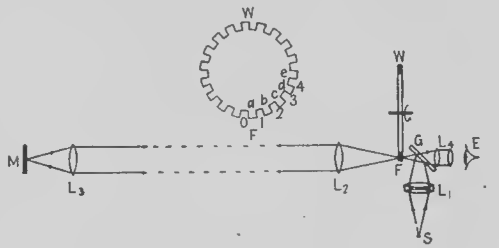

Fig. 2—Fizeau's apparatus for first terrestial determination of velocity of light.

The cogwheel FW was rotated, at the focus of lens L_2, and light was flashed at the rim. Thus the light passed through the rim in a series of flashes. It was collimated by L_2 and focussed by L_3 on a plane mirror M. After reflection by M, the light retraced its path and was focussed by L_2 on the rim. If in the time the light went from F to M and back, the wheel had rotated so that a cog replaced the slit, the light would be stopped. By adjusting the speed of the wheel, every flash could be stopped by a cog and the light could be totally eclipsed. Obviously, there should be a fundamental velocity that will do this. The size of this velocity would allow the wheel to rotate through one cog while light went to the mirror and back again. Any odd multiple of this would also have the same effect. This order of velocity could be determined by assuming $c = 3 \times 10^{10}$ cm/sec. and thus finding K, which should be an integer in the eqn. $w = \dfrac{c(2K + 1)}{4\,dn}$.

Then, making this calculated value of K equal to the nearest integer, c is calculated by substitution in the given eqn. Therefore, knowing w (the angular velocity of the wheel), n (the number of cogs) and d (distance FM), c could be calculated in terms of known quantities. Fizeau thus obtained $c = 3.133 \times 10^{10}$ cm/sec. Young, Cornu and Forbes, independently improved the apparatus and obtained as a mean result $c = 3.014 \times 10^{10}$ cm/sec.

After this first terrestial determination of c, many experiments were performed and better results obtained for c.

The next person to attempt a determination was Foucault in 1850 (Fig. 3). His method used a rotating mirror instead of a cogwheel. By measuring the displacement of the image produced, Foucault could calculate c.

His apparatus is illustrated below:

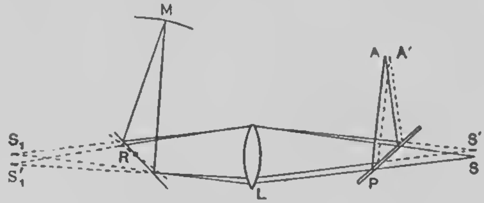

Fig. 3

Light from S falls on converging lens L and onto a plane mirror R which rotates about its centre which is also at centre of spherical mirror M. Due to rotation of mirror, image of S_1 does not coincide with that of S.

If $SL = a \quad LR = b \quad RM = D \quad S_1S = x$

then $$c = \frac{8\pi\, na\, D^2}{x(b+D)}$$

where n = no. of rev./sec. of R. Foucault obtained $c = 2.98 \times 10^{10}$ cm./sec. Michelson using the same apparatus obtained $c = 2.9985 \times 10^{10}$ cm./sec. in 1883, and Newcombe $c = 2.9986 \times 10^{10}$ in the same year.

The most accurate determinations of the velocity of light were made by Michelson, especially from 1924-31.

In 1926 at Mt. Wilson Observatory using a rotating octagonal mirror to obtain a stationary image in the same position as if the mirror were not rotating, he calculated the velocity of light from $c = 16Dn$, (where D = distance, n = no. of rev./sec. necessary for stationary image).

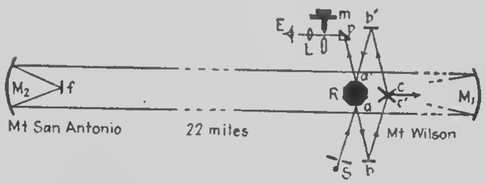

Fig. 4—Michelson's arrangement for determining the velocity of light (1926)

In 1929 Michelson, Pease and Pearson measured the velocity of light in a long evacuated pipe by a method similar to above

but using mirrors for multiple reflection in the pipe. They got a total light path of 10 miles by this means and obtained as a mean of 2885 determinations c = 299,774 km/sec.

In 1928, Mittelstaudt, and in 1937, Anderson, using the Kerr cell made determinations of c in a different manner altogether. The method of Anderson is as follows:

The Kerr cell consists of two parallel metal plates immersed in a suitable liquid, with a high voltage impressed on the plates. If a beam of plane-polarized light is incident on the cell, it is changed into elliptically polarized light. The phase angle delta is given by $\triangle = 2\pi BlE^2$ where B = Kerr constant of liquid, l = length of plates in direction of incident light beam, E = field strength.

If a radio frequency voltage is applied to the cell, the intensity of the beam varies as a sinusoidal function about the value which it has when the D.C. potential alone is applied. By means of a photo-electric cell, in which an R.F. voltage is developed, this voltage can be detected by a sensitive radio set equipped with an oscillator for creating an audible beat note. Thus if the beam is split so that one beam takes a direct path to the cell and the other a longer path, interference will result.

If e_1 = voltage developed by direct beam in photo cell,
e_2 = voltage developed by indirect beam in photo cell,

then
$$e_1 = E_0 \sin wt$$
$$e_2 = E_0 \sin (wt + a)$$

where $a = \dfrac{ws}{c}$ and

s = optical path difference of the two beams,
c = velocity of light
$w = 2\pi \times$ (frequency of R.F. voltage)

Thus total voltage
$$e = e_1 + e_2 = E_0 \sin wt + E_0 \sin (wt + a)$$
$$= 2E_0 \cos \frac{a}{2} \sin \left(wt + \frac{a}{2}\right)$$

$\therefore$ e is a minimum when $a = (2n + 1)\pi$ where n is any integer

i.e., when $\dfrac{ws}{c} = (2n+1)\pi$

Thus s (or w) may be adjusted till the minimum voltage is developed in the photo cell.

Then $c = \dfrac{ws}{(2n+1)\pi} = \dfrac{2\,fs}{m}$

where m = 1, 3, 5 - - - -

Approximating $c = 3 \times 10^{10}$ cm, and knowing f and s, m may be calculated. Since m must be an odd integer, m is equated to the odd integer nearest to the calculated value. Then this value was substituted back in equation and c calculated. Anderson obtained c = 299,779 km./sec. in vacuo.

Some indirect methods have also been tried.

In 1923, Mercier attempted to measure c by measuring the velocity of electric waves along wires. He sent out high frequency electric waves along one of two adjacent and parallel wires and back along the other to produce standing waves. By measuring distance between nodes produced, the wave length can be found and knowing the frequency, c can be calculated from c = (f) (wave length). Mercier obtained c = 299,720 km/sec.

Another method has been to find the ratio of the electrostatic and electromagnetic units of electricity, i.e., the ratio of

$$\frac{C_1}{C_2} = c^2$$

where C_1 = capacity in e.s.u. of a condenser,
C_2 = capacity in e.m.u. of the same condenser.

Thus for a cylinder of known geometrical dimensions

$$C_1 = \frac{Ke}{2 \ln \frac{r_2}{r_1}}$$

where
K = dielectric constant
r_2 = outer radius
r_1 = inner radius.

C_2 could be measured by a bridge measurement. Thus c^2 and therefore c could be determined. By this method Rosa and Dorsey (1906) obtained c = 299,781 km./sec.

Thus from all measurements, within the limits of experimental error, the velocity of light was found to be a constant; approximately 2.998×10^{10} cm./sec. The knowledge of the exact value of this constant was necessary for a great many operations in

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MINERAL FLOTATION

by JOHN H. WOOD, (Hon. '46)

THE separation and extraction of metals from ores by the flotation process is of quite recent origin, and because of its comparative simplicity and economical operation, has been adopted by all modern and up-to-date mills as the standard process.

It was in 1898, when F. E. Elmore patented a bulk oil flotation process for the concentration of gold-bearing chalcopyrite ore that he foreshadowed a new era in metallurgy. However, not until 1903, when the English firm of Minerals Separation Limited began to explore the possibilities, was the potential value of this method of metal separation from ores realized, and their experiments eventually led to the refinements which are now used.

Today, hundreds of plants of all sizes, from small mills treating 25 tons of ore a day, to the giants like the Arthur and the Magma Mills in Utah processing as much as 30,000 tons of low grade ore daily, base their entire mineral separation upon the use of the flotation process.

Essentially, the flotation process is a method which permits concentrating a finely ground low grade ore, usually a sulphide, so that the valuable minerals may be worked without the prohibitively expensive treatment of the gangue (non-mineral bearing waste rock).

As an example of the effectiveness of the process, let us consider the Magma Mill, already referred to. In 1929 it was treating an ore containing less than 1% copper, and obtained from it a concentrate with an assay of 32.9% Cu, and, moreover, extracting 93% of the copper originally present in the ore. Prior to the introduction of the flotation process, such high percentages were economically impossible with such a low grade ore.

The present metallurgical practice requires that the ore be crushed and then finely ground in water, in ball mills, so that about 60% of the ore entering the flotation circuit is less than 200-mesh, i.e. will pass through a screen of 200 mesh to the inch. The density of the mixed water ore pulp, when it starts its journey through the flotation circuit, is normally such that it contains 40-60% solids.

To this is added the required amount of reagents, usually about 3 lbs. in all per ton of ore. Of this, a major portion is solely for controlling the pH of the circuit, chemicals like CaO, Na_2CO_3. With violent agitation, certain types of particles become coated with a film of the reagent, and upon introduction of air bubbles, millions of such particles cling to each of the bubbles which slowly rise through the pulp to the top, where the froth is mechanically removed by overflow into launders. By varying the reagents, first one, and then another component of this ground ore may be obtained.

The process depends entirely upon the fact that, for the particles of ore which float, there is no adhesion of water to the surface of the film of reagent. This is illustrated by considering the example of paraffin, which is not wetted by water, in contrast with glass, which is.

The concepts of Elmore in mineral flotation have undergone many changes since 1898. Basically, his separation was due to the buoyancy of the large amount of oil used. In 1902, Delprat and Potter introduced the use of air bubbles to create a froth. They used hot acid solutions which would react with

the minerals, and later gas producing compounds. The essential discovery was that of Froment, who found there is a selective action of the oil on the sulphides and, simultaneously, of the gas for oiled particles. From then on, study of the subject was carried on chiefly by Minerals Separation Limited, and to them is due much of the development of the modern technique. Their patent of 1908 specified the use of a fraction of 1% of oil per ton of ore in water pulp with violent agitation to produce the required bubbles.

Immediately the question arises as to how it is that such small amounts of reagents are sufficient. It should be realized that the oil film enveloping the particles need be only one molecule thick, or 30×10^{-8} cm. thick. In contrast, consider a solid cube with 1 cm. sides; the dividing of this into cubes with sides of the length of 30×10^{-8} would yield 37×10^{18} such cubes. Although this does not give the whole background, it will demonstrate the incredible area a small amount of liquid reagent may cover, and it may be said that the flotation process ranks as one of the most valuable contributions of colloid chemistry to heavy industry.

The final great advance came in 1924 and 1925, when the use of xanthates and other collecting agents was disovered. Without these collecting agents (which will be discussed later), the success of modern differential flotation could never have been achieved. Thus, all the more important advances in this field of metallurgy have been made in the last twenty years.

As the flotation process was originally used, only two products were obtained, a froth product and a "tailings", i.e. the nonfloatable material. The froth product, the concentrate, contains the desired minerals. As the process became more widespread, two, three (and in some few cases even more) successive separate concentrates were obtained when using a complex rock mixture; e.g. at the Flin Flon mill, here in Manitoba, copper and zinc concentrates are obtained. This differential flotation has been possible only with the introduction of many reagents. These reagents may be separated into three main groups—Frothing agents, Collecting agents, and Modifying agents.

Frothing Agents: As their name implies, these compounds produce and stabilize a froth suitable for use in flotation. They actually act at the interface between the gas and the liquid, i.e. at the surface of the air bubbles. They give the bubble elasticity, so that it will not break. This may be compared with the use, by children, of soap to blow bubbles, the soap in the water film giving the required elasticity and rigidity.

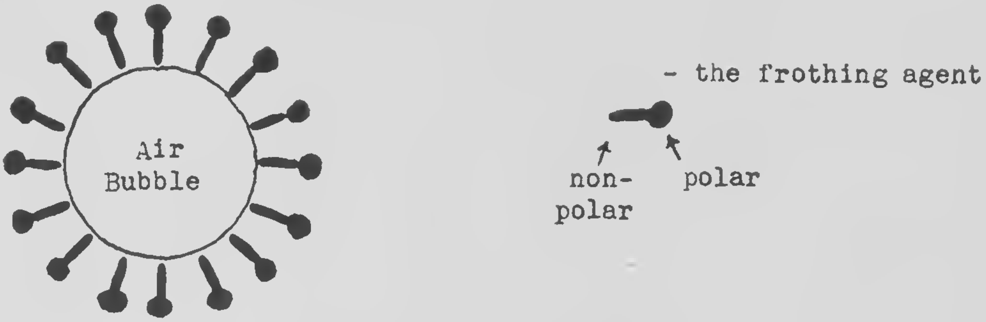

Fig. I—Orientation of Frothing Agent on Air Bubble (after Richards & Locke)

Frothing agents should not be collectors, i.e. they should not act differently with any particular mineral present in the ore. They are organic compounds with a polar and a non-polar group, which show no tendency to ionize. The polar group, containing an electrovalent linkage, has a great affinity for water; the non-polar group, a covalent linkage, repels water. Accordingly, when these molecules collect at an air-water interface, i.e. at the surface of the bubble, they group as in Fig. I.

These frothing agents have no other function than to stabilize the froth. They usually contain the —OH group as the polar part, since that group exhibits no particular collecting power. The commonly used frothers are Pine Oil (which contains terpeneol, $C_{10}H_{17}OH$) and cresylic acid, a coal tar distillation product containing cresols like $CH_3C_6H_4OH$, and xylenols like $(CH_3)_2C_6H_3OH$. Also the higher alcohols, and

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certain aldehydes and ketones, are widely used.

Collecting Agents: These are the chemicals that cause the collection of the desired minerals in the froth. They, too, contain a polar and non-polar part — but they are usually readily ionizable. The polar part serves as a means for the film or coating to adhere to the mineral. The non-polar groups render the film non-wettable or water-repellant, and allow the attachment to the froth bubbles.

An example of how these materials work would be the separation of galena (PbS) from silica (SiO_2) by the use of potassium amyl xanthate $(K)+(SSCOC_5H_{11})-$. The surface ions of Pb combine with and/or attract the xanthate ion, so that a layer is formed over the whole surface with the C_5H_{11} part, the non-polar part sticking outwards; see Fig. II.

Thus, it is apparent that the galena now has a paraffin surface which is non-wettable by water, and hence fulfills the conditions necessary for flotation. These particles attach themselves to the froth bubbles as they rise through the ore pulp.

Many different collecting agents have been introduced in the last fifteen years, a large number of which influence only a few minerals. Amongst the common collectors in use, the xanthates are perhaps the most abundant, both as sodium and potassium salts. Some of the more common collectors are given in Table I. R in each case represents the group (CmHn).

TABLE I

Name	Structure
Xanthates	H- -S-C-O-R ‖ S
Dithiophosphoric Acids	-O-R H- -S-P ‖-O-R S
Thiocarbanilides	$=N-C_6H_5$ H- -S-C $—N-C_6H_5$ | H
Mercaptans	H- -S-R
Dixanthogens	R-O-C-S-S-C-O-R ‖ ‖ S S

The last type shown, the dixanthogens, obviously does not have an ionizable structure, but when used it is found to be subject to reduction to a xanthate type.

Modifying Agents: These are used so that the desired mineral(s) from the pulp will be collected into the froth, but not the remaining material. It is with this group of

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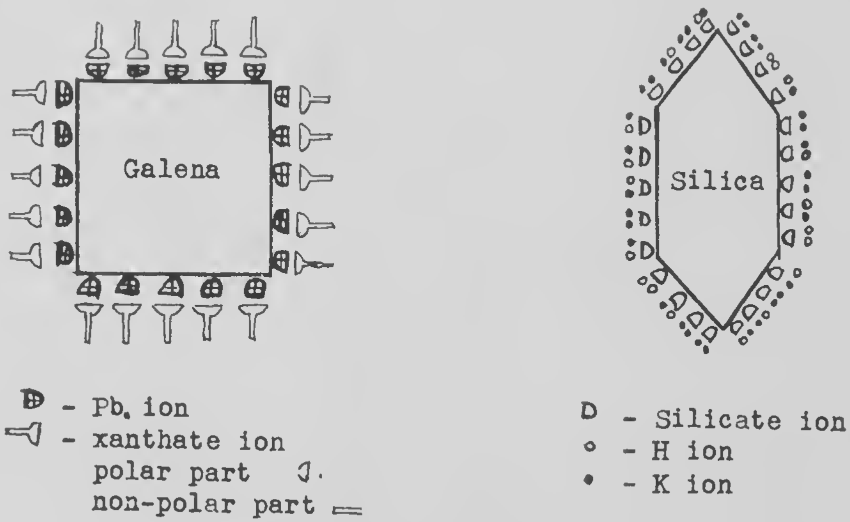

Fig. II—Orientation of Potassium xanthate on PbS and SiO_2 (after Gaudin)

The BADGER BOY of Manitoba

by PETER J. HAMPTON, M.A.
Associate Professor of Psychology,
Western College, Ohio

From time to time, from far-flung regions of the world, come stories of children who have been carried off to the dens of wolves, caves occupied by bears, and to other dwelling places of wild animals. Scientists eagerly collect every scrap of data relating to the lives of these feral children because they contribute greatly to the study of human nature. The stories of feral man include infants reared by leopards, bears, wolves and baboons. They are stories of soul-stirring tragedies; but they are important for they have lessons to teach—lessons on the value of environment. The Badger Boy of Manitoba is one of these feral children, the only Canadian one on record.

NOT FAR from Winnipeg, at Birds Hill, there lived in the latter part of the last century a strange boy—strange because he had an uncanny way of making animals his intimate friends.

Harry Service was different from other children from the very first day of his birth in 1864. Unlike other youngsters, Harry was completely in tune with the animal world. It held few secrets for him. If it had not been for his human body, he might easily have been taken for an animal.

While other children played "hide and seek", and the many other games that make of childhood such a carefree period of life, Harry played with chickens, pigs, dogs, birds and many of the wild animals of the prairies. He was perfectly at home with these creatures, imitating their actions and their voices to perfection.

One day in 1871, when Harry was seven years old, he followed a prairie chicken into the fields, imitating its clucking and nodding his head whenever the prairie chicken would do so. Farther and farther he wandered, away from his home, until finally the homestead was completely hidden from view by the trees that fringed the river. Harry was lost.

It was not the first time that Harry had absented himself from the house. His parents were used to the boy's wanderings and paid little attention to them. This afternoon was different, however. The clouds were ominous. An impending thunderstorm was in the making. Mrs. Service feared that Harry might get wet and catch a cold. And so, in response to her promptings, a search for the boy was undertaken by Mr. Service and his neighbors.

All that afternoon and the next day and the day following, the search continued, but without success. Harry had disappeared, leaving no trace. Finally the neighbors gave up the search and went back to their daily tasks, convinced that the boy had drowned and had probably been carried away by the near-by river. But the parents kept up the search, even though there now seemed little hope that little Harry would ever be found alive.

Meanwhile little Harry, unknown to his grieving parents had found safety in a badger den.

On the afternoon in question, Harry, finding that he was lost, had taken cover in a badger's hole, where he stayed all afternoon. When darkness fell the rightful owner of the den, a female badger appeared, and tried to evict the intruder. But Harry would not budge. Said he later, "I scratched the badger's face and she scratched mine." The badger at last decided to find shelter for the night elsewhere, and left the boy alone.

Then loneliness overcame the boy and he began to cry for his mother, but she was far away and could not come to his rescue. Finally Harry cried himself to sleep.

In the morning he was thirsty and hungry. Crawling out of the hole, Harry quenched his thirst by lapping up some of the water that the rain had deposited in a small incline in the ground. For his breakfast he ate a few of the rose nips that he found on the bushes near the hole.

A rider passed by in the distance. Harry was going to cry out after him and make known his presence, but when he recognized in the rider the halfbreed Grogan, one of the Service's neighbors, whom Harry thoroughly hated, he crawled back into the hole and hid. Other riders passed by in search of Harry, but the boy let them be and remained in the comparative safety of the badger hole.

What was it that made Harry so bitter against Grogan? And why did Harry not reveal his hiding place when other friendly neighbors, and even his dad passed by the hole? Harry knew that Grogan was cruel to animals, and he was afraid that these men would hunt down and kill the badger in whose hole he had found shelter. To Harry this possibility was much more important than his own safety.

Harry vividly remembered the cruel things Grogan had done to the badgers. Only a short time before Grogan had set steel traps at a den where several peaceful badgers lived. The first night Grogan had captured the father badger. Finding the animal in the morning with both of his paws helplessly entrapped, with blood all over, bearing silent witness to the anguish and pain the badger had had to endure, Grogan seized a club and bludgened the badger to death.

The next night the mother badger was caught in Grogan's trap. For three days the mother badger suffered in the trap while her young ones were starving. She finally escaped, but when she returned to her den her babies were all dead. Grogan meanwhile had been drinking up the money he had received for the badger pelt, all the while bragging about what a great hunter he was.

Hunter? Vicious and cruel was Grogan, and Harry, who loved animals could not forget. Why should he, Harry, now be the instrument for another vicious act by the detestable Grogan? Better suffer himself than have the innocent and helpless badger suffer because of him.

The animal world is a strange world. Animals do not speak, but they understand. It was not surprising, therefore, that the badger, whose home Harry occupied, soon realized that the boy meant her no harm, but instead, tried to protect her. Call it instinct if you will.

Suffering so grievously at the hands of man—for the badger whose hole Harry occupied was the badger mother who had lost her husband and her babies to the cruelty of Grogan, and who herself had spent three miserable days in his trap—the badger mother nonetheless refrained from what man would have done in a similar situation. She did not generalize and begin to hate all men. Here was a boy, who, although a man-child, meant her no harm, but needed her help. The badger decided that he was not to meet the fate her own children had met. She knew that Harry needed food, and so at noon, the second day, she appeared at the hole with the body of a prairie chicken in her mouth.

Entering the den, the badger deposited the chicken before Harry, who immediately grasped it in his little hands and devoured it. Later in the day, when Harry had fallen asleep the badger came and slept beside him, keeping him warm with her furry pelt. In the evening the badger brought Harry the egg of a prairie chicken, and as before deposited her booty before him. The boy broke the egg and eagerly devoured it. Then he went outside and again quenched his thirst by lapping up some more of the water in the near-by puddle.

During the night it rained again. It was clammy in the hole, but the badger came and cuddled around Harry and kept the boy warm. Several times she licked the boy's face. The badger was lonely, having lost both her husband and her babes. Her heart cried out for something to love, and Harry had become that something. The badger adopted him, and in her animal fashion, did everything to make the boy comfortable.

Days passed. The men in search of Harry still rode by the badger's home, but Harry shunned them. He had come to look to his foster mother, the badger, for food and pro-

tection. And the badger mother was happy to provide both.

Harry gradually accustomed himself to the badger's life. The badger provided him with a variety of foods, not all of which were to the boy's liking. There were dead mice, ground squirrels, eggs of game birds, combs of honey from bees' nests, and once the badger even brought a piece of bread which she must have retrieved from some traveller's lunch bag. Harry's biggest problem was water. Fortunately it rained at frequent intervals so that Harry did not have to go without water for long periods at a time.

As life went on from day to day in the badger domicile, Harry gradually copied the badger's growls, snarls, and purrs, and soon completely adapted himself to badger life. He played tag with his badger foster mother on the prairie, but whenever men neared, both badger and boy rushed into their den for safety. In two weeks Harry had all but become a badger himself, as far as the daily routine of life was concerned. And he seemed happy in his new animal life, happier than he had been before, living amongst men.

But cautious as Harry was, one morning, in search of water, he strayed a little too far from the safety of the badger home. A passing rider saw the boy and gave chase. Harry tried his best to get back to the hole. Running on all fours, he eluded the rider for the time being by dashing into the tall prairie grass. But leaving the tall grass, Harry ran for the hole which was located in a bare patch of ground and backed into it, and that proved his undoing.

The rider, who happened to be Harry's cousin, Jack, recognized the missing boy. He rode up to the hole, leaped off his horse and called out, "Harry! Harry! don't you know me? I'm your cousin Jack." But coax as he would, Harry would not come out of the hole. Instead, he retreated still farther into the hole, where Jack could not reach him. Again Jack called, "Harry, won't you come out and let me take you back to mama? Come Harry! Look! here are some cookies."

However, Harry would not be persuaded. He hissed and snarled at Jack and backed up still farther into the hole. Then Jack got out his pocket knife and dug into the burrow until it was large enough for him to crawl in. He seized one of Harry's arms and pulled him out of the hole struggling and crying.

Realizing what was happening, the badger now rushed out of the hole. Thoroughly aroused at the inhumanity of man, the badger, angry and snarling, charged at Jack uttering fighting snorts. Jack fought the badger off with his whip as best as he could. Then he swung into his saddle with little struggling Harry in the grip of his left arm and rode away at full speed towards Birds Hill.

The badger followed in pursuit, but the rider soon out-distanced the enfuriated little animal, and the badger, very sad, went back to its hole which now that Harry was gone was as desolate and lonely as it had been when the badger had found her little brood dead of starvation. For the second time the badger mother had lost what she prized over everything in life.

There was great rejoicing at the Service's home when it was learned that Harry was not only alive but well. The father was the first to see his son. Still in search of the boy, he was suddenly startled by Jack who came riding across the prairie shouting, "I have got him, thank God!" The father turned pale and held his breath. Then he rushed forward with the words, "My boy! my boy" coming from his throat like sobs of relief.

But, if Mr. Service had any notion that Harry would be full of happiness at seeing his father again, he was sadly disappointed. Harry only glared at his father like some hunted cat, all the while letting out ominous hisses and menacing his father with his hands which the boy held claw-like. There was no love in Harry's expression. There was only fear and hate.

Mrs. Service was received no better by the boy. "My darling! my darling!" she sobbed. But Harry would not be moved. He held back, hid his face, snarled, and scratched whoever came near.

Then a transformation took place in the boy. It was as sudden as it was unexpected. When the men had taken Harry forcefully into the house, they placed him on his mother's knees as of old. The old environment did something to Harry. There was the old clock ticking away oblivious of the fact that Harry had ever been away. There were the old pictures on the walls. There was his sister's voice, his father's form, and there was the smell of frying bacon. But best of all, there were his mother's arms about him, her gentle touch on his brow, and her cooing voice saying, "My darling! my darling! Oh! Harry, don't you know your mother? My boy! my boy!"

Harry stopped struggling. His anger died away. His hissing gave place to a low panting. Then a few sobs from his throat, ending in a flood of tears and a passionate and

bewildered outburst of "Mamma, mamma, mamma." The animal life which had hung over Harry like a veil, suddenly lifted, and the boy clung to his mother's bosom with all his might.

Then, lo and behold! A strange hissing sound came from the doorway. Everyone in the room turned around, and there, with its front feet on the threshold, stood a great badger. The men grabbed for their guns, intent on killing the creature. But before they could carry out their purpose, Harry let out a scream, broke away from his mother, and rushed to the open doorway crying, "My badgie! my badgie!" He flung his arms around the badger's neck and the badger responded with a low purring as she licked Harry's face. The men insisted on killing the badger, but the mother would not have it. She had her way, and in due time the badger became a member of the Service household.

The days that followed witnessed a curious sight. Harry oscillated between a human and an animal existence. On occasion he would behave like any other boy, but often he passed into an animal existence, running on all fours, growling, hissing, and tussling away with the badger.

Harry insisted that the badger sleep with him in his own bed. The mother, jealous of the badger, nonetheless granted almost every wish Harry expressed. She knew that the only hope of winning Harry back was to grant his strange animal desires. Many a night she stood beside Harry's bed, with tears in her eyes, as she watched her baby curled up with the badger, wondering whether she would ever win his love again.

Then tragedy came in the form of the despicable Grogan. Says E. T. Seton, who first gave the story of Harry and the badger to the world, "Grogan, the unpleasant neighbor, came riding up to the Service homestead. Harry was in the house for the moment. The badger was on thc sand pile. Instantly on catching sight of it, Grogan unslung his gun and exclaimed, 'A badger!' To him a badger was merely something to be killed. 'Bang!' and the kindly animal rolled over, stung and bleeding, but recovered and dragged herself back toward the house. 'Bang!' and the murderer fired again, just as the inmates rushed to the door—too late."

"Harry ran toward the badger shouting, 'badgie! my badgie!' He flung his baby arms around the bleeding neck. It fawned on him feebly, purring a low, hissing purr, then mixing the purrs with moans, grew silent, and slowly sank down, and died in his arms. 'My badgie! my badgie!' the boy wailed, and all the ferocity of his animal nature was directed at Grogan."

"You better get out of here before I kill you!" thundered the father, and the hulking halfbreed sullenly mounted his horse and rode away.

A great part of his life had been cut away and it seemed as though a death-blow had been dealt the boy. The shock was more than he could bear. He moaned and wept all day, he screamed himself into convulsion, he was worn out at sundown and slept little that night. Next morning he was in a raging fever and ever he called for "my badgie". He seemed at death's door the next day.

The crisis came. Would Harry live or would he die? The parents were frantic with apprehension. Then kind Providence stepped in. Harry passed the crisis and slowly began to recover. In a few weeks the whole episode seemed like a ghastly dream.

But Harry never quite got over his terrible experience. He grew up into a strong man, followed in his father's foot-steps, and tilled the land, but until his dying day he would not kill a badger. His love and tenderness for animals remained with him all his days.

Who is to say where the animal world begins and that of man leaves off? Man, the self-appointed lord of the earth little knows that animals, the animals over which he is master, and which he uses as a means to his own puny ends, are often more human than he is himself.

The badger is a little animal, inconspicuously going about his daily tasks. We take him for granted, killing him when he crosses our path, cursing him when we step into one of his burrows on the prairie, gaping at him in the zoo. But, do we take a lesson from him or the many other animals that we find about us?

Faithful, unselfish, often giving his life to save ours, we insignificantly tolerate him or destroy him as it suits our fancy. Few human lives have as much to teach us as the life story of this badger who befriended little Harry, saved him from starvation, fought off his captor when there was no hope of success, and finally gave his life for man who had done his worst to him.

All the pathos, all the sorrows and joys, and all the great aspirations of man's soul are exemplified in the life story of this humble badger.

TO THE STUDENTS:

DR. McLEOD, *Honorary President*

DR. J. A. McLEOD
Honorary President

My thanks to the editor of the Question Mark for this opportunity to say a few words to the science students in general and the members of the graduating class in particular. It has been truly said that the present is only a fleeting instant between the past and the future. Let us consider our position in terms of these. You have now reached your first objective—graduation. True, it has involved much expense and hard work on your part but the greater portion of the burden has fallen on your fellow citizens both past and present. Because of their efforts the privilege of a university education has been made available to you. Your best method of repaying them is to accept your full responsibility of citizenship and apply your training zealously for the common good.

Courage and enthusiasm are the greatest attributes of a scientist. Your ancestors who pioneered this country possessed both to a marked degree. I venture to say that members of this generation have not lost anything of these admirable qualities. And so, in the phraseology of the army I say "Carry on Canada" and may happy, useful, and successful lives be your reward.

JACK COUTTS, *Senior Stick*

JACK COUTTS
Senior Stick

I could use this space to give a dissertation on the role of the Science student in wartime—but you have all heard and read much on that subject; I could mention the important part that our large and enthusiastic faculty plays in University student life—but no Science student needs to be reminded of that; I think that this space could best be used to express my heartfelt thanks to every Science student, and to the members of council in particular, on the way they have worked to make 1944-45 a very successful session.

I feel certain that the many who have worked on various committees and in unofficial capacities will not feel slighted if I mention a few in particular. Mary Mustard deserves commendation for the energetic manner in which she organized the highly successful blood donor and I.S.S. drives in Science, as does Don McKenzie for his excellent organization of our extensive social programme, and John Wood for his revival of the long dormant Scientific Society, a truly worthwhile endeavor. Fred Zeiler and Joan Hepworth have handled men's and women's athletics in a vary capable manner, while Yvonne Claeys has devoted many hours to producing this most excellent edition of your magazine. Eileen McFetridge and Earl Pashkovsky have been of inestimable assistance in executing the many administrative duties of council.

It means a great deal to any Senior Stick to have capable officers in Junior Division; and Anne Campbell and Don MacDonald certainly "fill the bill". They head a most co-operative and enthusiastic Junior Council. I find it hard to put in words my gratitude to Grace Musker for the truly wonderful way in which she has filled her office. I only hope that my successor, who will proably have been elected by the time this paper appears in print, may be favored with the co-operation of as efficient a lady stick and council as I have been in 1944-45.

GRACE MUSKER, *Lady Stick*

GRACE MUSKER
Lady Stick

As your editor-in-chief has asked me to enclose a brief message from the Science Ladies' Club, I think it appropriate that I should, on behalf of the women students, congratulate her on her successful edition. She is the second member of our Club to accomplish this task—so you see we do offer possibilities.

This, of course, hasn't been our only accomplishment. The cooperation of the initiated members provided a jolly welcoming tea for the freshettes at the opening of the year and also a very gratifying faculty reception later in the season. The Science Meetings cannot be overlooked for at these the S.L.C. provided the all too necessary refreshments. For the aformentioned and our outing this term, not overlooking the Graduates' Luncheon, our appreciation is extended to our very conscientious Social Chairman.

We mustn't omit our athletic feats(?)—our scorers are not noticeable but we can be proud of the fact that our attendance is evident at every game—due to the enthusiastic efforts of our Athletic President.

Many of our former colleagues are in the forces and they were not forgotten by the Science Students during the Festive Season as Xmas Cards were mailed to them by the Science Ladies' Club. It is hoped that this effort will be continued and improved upon in the future—it is our privilege to be offered the opportunity to study during the present conflict, let us take this means to show our appreciation.

The cooperation which is apparent this year has in no small measure been stimulated by the consideration individual students have offered each other, encouraged by the courtesies of our Honorary President and the interest of our Dean of Women.

I sincerely trust the balance of this term will be happy and profitable for each of you—may I say thank you for the pleasant associations and the assistance extended to me.

The Canadian Association of SCIENTIFIC WORKERS

IT HAS BEEN shown that when the resources of science have been fully utilized, scientific workers have been able to make extremely important contributions to the war effort. They can make even greater contributions to the welfare of the people in post-war years. But if they are to do so, they must solve many problems relating to their role in reconstruction and to their social and economic status.

The Canadian Association of Scientific Workers is being formed to unite all Canadian scientific workers in a single organization similar to those of Australia, New Zealand, South Africa, U.S.A., and to the large and powerful British Association. It will be able to use the experience of its sister organizations in dealing with problems faced by scientific workers here. Branches have been formed in Montreal, Ottawa, Toronto, Kingston, London, Guelph, and Fredericton, and are being organized in various other centres across Canada. At a recent meeting of scientific and technical personnel in Winnipeg, it was decided to form a Winnipeg branch of the C.A.Sc.W.

The scope of the proposed C.A.Sc.W. program is wide. It is partly for this reason that the Association cannot be considered as an alternative to existing professional bodies. Some of the principal aims are as follows:

(1) To ensure that the applications of science be directed primarily toward the improvement of conditions of life, and to promote the fullest utilization of scientific research in industry, public health, agriculture, Arctic development, wild life control, and conservation of natural resources. To combat all tendencies to limit scientific investigation or to suppress scientific discoveries; to expose pseudo-scientific theories and claims whenever such are used as justification for harmful social and financial ends or policies. To strive for enlightened public opinion regarding the nature and implications of scientific work, and the conditions which can assure its greatest effectiveness.

(2) To urge that scientific research be adequately financed, and to stress the need and importance of government supported research programs on a coordinated national basis. To secure direct representation of scientists on all government bodies whose findings, work, or other activity, involve the application of science; to urge the formation of parliamentary science committee and advisory bodies, and the application of their findings. To advocate that positions requiring scientific understanding shall be filled by people with scientific qualifications.

(3) To combat all efforts to limit opportunities for scientific education or to discriminate, economically or otherwise, in the practice of the scientific professions on the basis of sex, race, creed, or color. To ensure the fullest recognition of the economic, cultural, and social values of science, and to promote the adequate and proper teaching, by competent instructors, of science and the scientific method throughout the educational system. To advocate the establishment of a government financed scholarship system so that scientific training may be available to all students with an aptitude for it.

(4) To maintain and extend the international character of science by fostering the interchange of scientific workers and information between scientific institutions throughout the world.

(5) To ensure for scientific workers in general adequate remuneration, security of tenure, and satisfactory conditions of employment, and to represent them in their relations with their employers. To provide members with information and advice concerning conditions of employment, and to assist them in obtaining legal advice thereon when necessary. To assist and advise students in relation to their future employment.

Membership in the C.A.ScW. is possible in one of three categories—student member, associate member, or full member. Further information may be obtained from Mr. M. J. McLeod, Science Building.

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Principles of Television

(Continued from Page 13)

transmission of such a complex wave it is possible to maintain the required synchronism between receiver and transmitter without interferring with the picture transmission.

A consideration of the essential parts of a television receiver is now in order. As shown in Fig. 6 the complex wave from the transmitter upon arriving at the receiver enters a separator circuit which is capable of separating the video frequency picture waves, the horizontal synchronizing pulses and the pattern of vertical synchronizing pulses. Each of these is amplified separately as indicated in Fig. 6. The picture tube is a cathode ray tube. This consists essentially of an electron gun similar to that in the iconoscope of the transmitter and a screen which fluoresces when the electron beam from the gun strikes it. The intensity of the electron beam is controlled by a voltage from the video frequency amplifier to one electrode of the gun in such a manner that the electron beam is cut off entirely when the incoming wave is above the "black level" but is proportional to the brightness of the picture element being scanned at the instant for all levels below the black level. The motion of this electron beam over the fluorescent screen is controlled by magnetic fields due to two pairs of deflection coils similar to those used to control the scanning beam of the transmitter. Each pair of coils is actuated by the current from a scanning generator identical with the corresponding scanning generator of the transmitter and maintained in exact synchronism with that generator by means of the amplified synchronizing pulses received from the transmitter. Hence, the electron beam of the picture tube traverses the fluorescent screen along the same geometrical path and at the same rate as that followed by the scanning beam of the transmitter in scanning the original picture. Further, the intensity of the electron beam and, therefore, the brightness of fluorescence produced is at every instant proportional to the brightness of the picture element being scanned by the transmitter at that instant. In other words, the purpose of television has been accomplished, namely, a picture has been produced at the receiver corresponding to the original picture or scene at the transmitter.

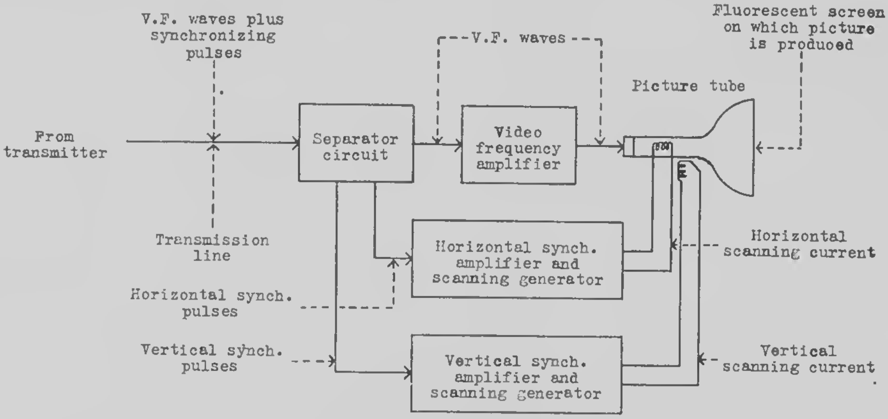

Fig. 6—Block diagram of television receiver (wired transmission)

So far this article has dealt only with wired television. In practice, television transmission by wire is seldom used because of the high cost of coaxial cable or any other cable over which the high video frequencies can be transmitted without high loss of energy. This economic consideration seems to preclude any big development of wired television for the home, (e.g., as an adjunct to the telephone) unless a suitable low-cost durable cable can be developed or a television system can be devised which does not require very high video frequencies. While the immediate prospect of wired television for the home is slight it appears that the use of wired transmission for special purposes such as theatre television may be feasible.

This article has dealt with wired television only since its object is to illustrate the

fundamental principles and processes of television and these are all included in a discussion of television transmission by wire. While almost all the practical developments in television up to the present have been in the field of wireless television, these developments involve no principles or processes other than those described above in connection with wired television and those already applied in commercial radio broadcasting. Wireless transmission of television waves by means of a radio frequency carrier wave is identical in principle with the method used in present-day radio broadcasting of sound waves and, in practice, differs in only one respect. Because of the very broad video frequency band which must be transmitted it is necessary to use a very high radio frequency for picture transmission (over fifty million cycles per second as compared with radio broadcast frequencies of the order of one million cycles per second). Due to the fact that very high frequency waves travel in straight lines and do not follow the curvature of the earth to any appreciable extent, reliable wireless television reception is limited, therefore, to a distance of fifty miles or less from the transmitter. Despite this limitation there is every reason to expect a rapid growth of commercial television broadcasting on this continent after the war (at least, in densely populated areas), a confidence justified by the success of recent experimental transmissions in the United States and by the fact that in England, even before the war, there were regular television broadcasts during a three-hour period every day with some 25000 home receivers in use.

Mineral Flotation

(*Continued from Page* 29)

reagents that selective flotation is made possible, by the activation of one mineral first, and then a second, etc.

Perhaps the most important of these are the pH control reagents, using lime, soda-ash, and sulphuric acid. Most mineral flotation is carried out in alkaline circuits.

For example: sodium diethyl dithiophosphate will collect galena (PbS), chalcopyrite ($CuFeS_2$) and pyrite (FeS) under suitable conditions of H-ion concentration. If the reagent were in a concentration of 25 mg. per litre, then the chalcopyrite could be floated from galena with a pH range 7-9, and galena from pyrite with pH range 4-6.

However, another equally important reagent is sodium cyanide (NaCN) whose use is intimately tied up with that of pH control. This reagent, whose action is presumably due to the formation of complexes, is widely used to depress zinc in sphalerite (ZnS), and iron of pyrite (FeS), so that galena or chalcopyrite may be first obtained. In this use, $ZnSO_4$ is also frequently used with the NaCN.

After the copper and/or lead have been removed, it is necessary to activate the zinc again before it, too, may be recovered. This is done by $CuSO_4$ solution, which reacts by direct substitution

$$ZnS + Cu^{++} = CuS + Zn^{++}$$

so that the zinc, being coated with copper sulphide, is then free to be floated as was the original copper. If excess $CuSO_4$ is used, it activates the pyrite iron in a similar manner.

As has been mentioned before, mineral flotation usually involves sulphides of the metals. Now many metals occur in an oxidized state. Such minerals require too great a quantity of reagents to force flotation, but if they are treated with sodium sulphide (Na_2S), a layer of fresh sulphide adheres to the surface, and thence the material may be floated by ordinary means.

Of course, the outcome of specialized differential flotation has been the development of combination frothers and collectors designed for specific types of ores.

In addition to the sulphide minerals, flotation practice has been adapted to the treatment of oxidized ores of lead and copper, and the native ores of copper and gold. Even non-metallics, like coal, have yielded to this method of treatment.

This convenient and relatively inexpensive method of concentrating low grade ores has resulted in many mines, once presumed to be exhausted of workable ore and hence abandoned, to be re-opened and profitably operated. Also, many of even the larger mines, today being operated on a commercially profitable basis, might never have been opened if the flotation process had not been available.

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. . . Mental Diseases

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of cutting the white matter of each prefrontal lobe in the plane of the coronal suture. This means that the pathways which carry sensory impulses to, and motor impulses from the cerebral cortex are interrupted. The function of the frontal lobe, according to Strecker of Philadelphia, is that "It is the organizer of the personality, the structure underlying the social sense, and the determiner of behaviour." Its main connections are with the thalamus, which is the geometrical centre of the brain and acts as a central station for the recognition of bodily activities and the appreciation of sensation. The aim of the operation is to change the behaviour pattern of the individual. Patients are selected who show behaviour patterns emphasizing panic, destructiveness and rage reactions. They are violent, dangerous and may injure both staff and patients. Frequently they are untidy in habits and clothing. No patient shows all this abnormal behaviour but all patients show many features of it. Operative results on the whole have been quite hopeful. In several cases there has been marked improvement in behaviour, the patients becoming clean and tidy in habits, and well behaved on the ward.

In conclusion we know that people are becoming mental health conscious. We believe the basic problem of any health programme is the prevention of disease, and this includes the prevention of mental illness. The first problem is one of education, including pre-natal care, child guidance clinics with the solution of behaviour problems, to ensure the normal development of the child. If a psychosis develops we urge early consultation in an adult out-patient clinic or admission to a mental hospital. Under modern psychiatric treatment the majority of cases make a good recovery.

. . . Humphry Davy

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to fight our battles but an Agamemnon to command the Greeks".

Early in 1825, Davy had begun to complain of loss of strength and in 1826 he had an apoplectic attack. He made two journeys to the continent for the recovery of his health, but after four years of wandering, he died at Geneva on May 29th, 1829. His brother John, who had become a distinguished naval surgeon, was with him and wrote: "Respecting the nature of the complaint and the immediate cause of the death of my dear brother, I have nothing to state that is at all satisfactory to myself". Davy had said that there was to be no post-mortem examination, so the "exact kind and immediate cause of his death must ever remain doubtful." His body was buried at Geneva, for he had expressed the desire that it should be buried wherever he died.

Of a sanguine somewhat irritable temperament, Davy displayed characteristic enthusiasm in all his pursuits. In spite of his ungainly exterior and peculiar manner, his happy gifts of exposition and illustration won him extraordinary popularity as a lecturer, his experiments were ingenious and rapidly performed, and Coleridge went to hear him "to increase his stock of metaphors." Though his ambition sometimes betrayed him into petty jealousy, it did not leave him insensible to the claims on his knowledge of the "cause of humanity", to use a phrase often employed by him in connection with his invention of the miner's safety-lamp. Cuvier, in his Eloge, says: "Davy, not yet fifty-two years of age, occupied, in the opinion of all that could judge of such labours, the first rank among the chemists of this or any other age." Another critic has said: "He was not only one of the greatest, but one of the most benevolent and amiable of men." His widow placed a tablet to his memory in Westminster Abbey, and a statue was erected to him in Penzance.

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. . . Modern Algebra

(*Continued from Page* 18)

rem. Every single property of the real numbers, employed in high school and college algebra can be proved by the axioms and definitions of the complete ordered Field.

It will be recalled that addition and multiplication are defined as group operations, with subtraction and division as their inverse operations. Relating these with the distributive law, $a(b+c) = ab+ac$, we have the Field. Adding the properties of order and completeness, we have the basis of an algebra of real numbers which we have become accustomed to apply to daily problems in Science and business.

But if we leave out the properties and definitions of order and completeness, we can and do, construct a distinct algebra for vector quantities, in terms of the pure and general Field. All the laws of the field can be applied to the algebra of vectors and thus give a mathematical tool of real power in scientific theory.

So we have produced two useful algebras from the definition of a Field, which was in turn defined in terms of the Group. Modern algebraic theory encompasses many other powerful systems, all defined in terms of the group. Not only does the group concept unify our picture of the various mathematical systems, and clarify our understanding of their fundamental nature, but it also saves much in detailed, complex labor by necessitating only study of the most general group. By studying a group we study *all algebras*, and a result true for a group is established once and for all for every one of the many systems which become merely special cases. Therein lies the true power and beauty of the Group theory.

The Velocity of Light

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many branches of physics. e.g., electromagnetic theory, relativity and others. And no longer are we awed, like the ancients, by the magnitude alone of this constant, but by the ingenuity and intrepidity of the investigators in determining it.

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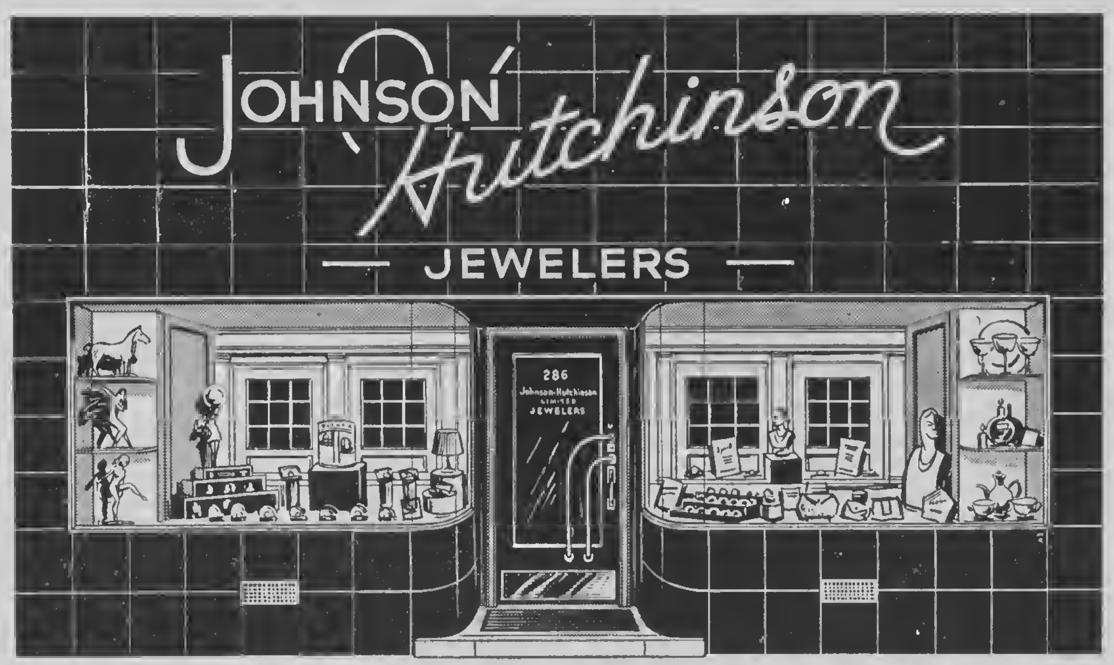
Science Yell

Hot Damn, Holy Hell,
Have you heard the Science Yell?
We want God knows,
More beer, less clothes.
S-C-I-E-N-C-E, Science!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